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SCHLICH'S
MANUAL OF FORESTRY

VOL. I.
FOREST POLICY IN THE BRITISH EMPIRE

BY

SIR WM. SCHLICH, K.C.I.E.

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A MANUAL OF FORESTRY.

SCHLICH'S

MANUAL OF FORESTRY

VOLUME I.

FOREST POLICY

IN THE

BRITISH EMPIRE,

BY

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PREFACE.

THE third edition of Volume I. of my "Manual of Forestry" contained an exposition of the General Foundations of Forest Policy, and a short account of the state of forest conservancy in the greater part of the British Empire. That account was, I believe, the first attempt of the kind, but it was incomplete owing to the difficulty of obtaining reliable information on many points. In July, 1920, the Imperial Forest Conference received thirty-four Statements from the different parts of the Empire containing a flood of new information, of which I have made full use in this fourth edition. The original statements cover 517 foolscap pages of close print, of which my friend, Mr. R. L. Robinson, the Technical Forestry Commissioner, has prepared an excellent summary and attached it to the Proceedings of the Empire Forest Conference. In this volume I have taken a middle course by recording all essential facts given in the Statements and omitting matter of less importance to the general reader. I have added, as regards each country, my personal views on the steps to be taken in the immediate future.

I hope that I have succeeded in giving a readable account of the condition of forest conservancy in the Empire as it stood in July, 1920. At any rate, the contents of the book may serve as a basis by which future progress may be judged.

I had intended to illustrate the book fully, but I had to abandon that project owing to the high cost of production at the present time. Nor have I added the conventional Index, which, in a book of this kind, would have been of doubtful utility. On the other hand, I have given a detailed Table of Contents, which should enable the reader to find without difficulty the desired subject.

It should be mentioned that, in the case of those parts of the

Empire with which I am not personally acquainted, the names of the trees have been given as recorded by the local authorities.

I desire to express my special thanks to my eldest daughter, as well as to my wife, for the assistance they have rendered to me in passing this book through the Press.

W. Schlich.

Oxford,
April 24th, 1922.

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FOREST POLICY.

INTRODUCTION.

Most people know what a forest is, but a definition of it, which suits all cases, is by no means easy to give. Manwood, in his treatise on "The Lawes of the Forest," 1598, defines it as follows :—

> "A forest is a certain territory of woody grounds, fruitful pastures, privileged for wild beasts and fowls of forest chase, and warren, to nest and abide in, in the safe protection of the King, for his princely delight and pleasure, which territory of ground, so privileged, is meered and bounded with unremovable marks, meers and boundaries, either known by matter of record, or else by prescription."

This shows that in Britain a forest was formerly an area set aside for the Royal chase. In modern times, when the economic aspects of forests came into the foreground, that definition gave way to others. In the early part of the nineteenth century, forest was defined as an area which contained wild growing trees. This definition is not correct, as many of the existing forests were artificially created. Another definition, given about the same time, defined a forest as "an area which has been set aside principally for the production of wood, and which, at any rate for the greater part, is covered with trees." Many areas are, however, classed as forest which do not contain trees, while others, such as avenues and hedgerows, bear trees and produce wood, although they cannot be classed as forests.

Owing to the difficulty of drawing up a definition which suits all cases, the Indian Legislature, when preparing a Forest Act for India, provided merely that "the Government may declare certain lands to be forest and as such be subject to the provisions of the Indian Forest Law."

Manwood's definition referred to what may be called "Primeval Forest," whereas more modern definitions refer to "Economic Forests." The former are the result of the action of natural forces only; the latter are produced, for the greater part, by man's interference with those forces.

By "Forestry" is understood the human action directed to the production and utilization of forest produce. It is based upon the yield of the land and forms, therefore, part of agriculture in its widest sense. Forestry, as now understood, was developed by degrees in the course of time. The greater part of the dry land of the earth was at one time covered with forest, which consisted of a variety of trees and shrubs grouped according to the climate, soil and configuration of the various localities. When the old trees reached their limit of life they disappeared, and others took their place. The conditions for an uninterrupted regeneration of the forests were favourable, and the result was continuous production. Then man came and interfered by degrees, until in the more advanced countries of the earth the area of the forest was seriously reduced. Moreover, the creative power of the soil in the remaining forest lands had become more or less impaired. Steps had then to be taken to arrest a further reduction of the forest area, artificial sowing and planting had to be done and the creative power of the land restored, a task which forestry had to undertake.

As long as the forests occupied a considerable part of the area, their produce was considered the free gift of nature, like air and water; man took it, used it, and even destroyed it without let or hindrance. Thus, *Forest Utilization* is the oldest branch of forestry.

With the gradual increase of population, more land was required for the production of food for man and domestic animals, and this was taken from the forest area. Reckless cutting and burning consumed more forest, and a time came when it appeared doubtful whether the natural woodlands could continue to yield the required produce for any length of time. This caused proprietary ideas to develop; people claimed the ownership of forest lands, proceeded to protect them against outsiders, and thus developed that branch of forestry which is called *Forest Protection*. Gradually the protection designed against man was extended to measures which had for their object the preservation of forests

against injurious attacks by animals, especially insects, noxious plants, in particular fungi, natural phenomena and other agencies.

By degrees it was found that mere protection was not sufficient, that steps must be taken to enforce a more efficient treatment and to limit the extraction of produce to what the forest was capable of producing ; in other words, to determine the annual or periodic production, and to regulate the yield accordingly. Thus the branch which deals with the Preparation of *Forest Working Plans* sprang into existence.

Something more was, however, required. With the increasing demand it became evident that the ordinary natural regeneration could not keep pace with the rate at which the mature trees were removed. It became necessary to assist regeneration by artificial means, either by arranging the cuttings so as to favour and assist natural regeneration, or by sowing and planting. Moreover, the young trees required special tending so as to produce the most useful description of produce. In this way a fourth branch of forestry was developed called *Silviculture.*

As time went by, forests rose in value ; they became articles of exchange or sale, and it was found necessary to devise a system of readily ascertaining their value. This produced another branch called *Forest Valuation* or *Forest Finance.*

Originally the protection which the owner of the forest could give to it was sufficient to guard it against mischief and interference. This proved no longer sufficient, and the owner appealed to the State for help. It was also found that certain forest lands were of special importance to the community as a whole, either on account of their produce, or for climatic reasons, or on account of the protection which they afforded to the soil of the forest and to adjoining lands. To regulate these matters, the State had to pass laws which are known as *Forest Laws and Regulations.*

With the development of Political Economy it was asked whether, and to what extent, forests need be maintained in a country, whether the State, as such, should hold the forests or whether their maintenance might be left to private enterprise. Thus, a further branch called *Forest Policy*, was created. It deals with the social and economic aspect of forestry, and considers especially the duties which the State has to perform as regards forests, so that they may, in the highest possible degree and the

most economic manner, meet the demands which are made on them in the interests of the community as a whole. The task of Forest Policy is of considerable extent, being practically a summary of conclusions based on the experience gained in the exercise of the several branches of the forestry business. It may, for the present purpose, be divided into the following two parts :—

PART I.—The Foundations of Forest Policy, dealing with the utility of forests, the factors of production, and the State in relation to forestry.

PART II.—Forestry in the British Empire, showing the manner in which the different parts of the Empire have shaped their forest policy in the past.

PART I.

THE FOUNDATION OF FOREST POLICY.

CHAPTER I.—THE UTILITY OF FORESTS.

Forests are, in the economy of man and of nature, of direct and indirect utility, the former through their produce, and the latter through the influence which they exercise upon climate, the regulation of moisture, the stability of the soil, and their sanitary, ethic and æsthetic effect upon man.

The utility of forests may be considered from the point of view of the owner or from that of the State. The private owner considers chiefly the benefits which he personally derives from the forests ; the State considers also the effects which they have upon the welfare of the people and the country as a whole. Hence, the former is chiefly concerned with the direct effects, and the State with both the direct and indirect effects.

SECTION I.—THE DIRECT UTILITY OF FORESTS.

It is divided into Major or Principal produce, comprising wood, and Minor or Secondary produce, comprising all other items.

1. Major Produce.

The yield in wood is obtained from periodic thinnings, or intermediate cuttings, and from the final cuttings at the age of maturity. The strength of the thinnings and the time of their execution are the most important matters with which the forester has to deal. If they are made too light, the remaining trees will not receive that growing space which is best for their future development ; if they are too heavy, the final returns are likely to be seriously reduced in quantity and quality, while the soil is exposed to deterioration through exposure. At the same time, the yield from thinnings favourably influences the financial results of forestry, provided

that any gain thus obtained is not neutralised by a deficiency in the final returns, or even more than neutralised. To make the thinnings of the right strength and at the right time is the best proof of the forester's skill.

The yield in wood is generally divided into timber and firewood, or fuel. Formerly the production of firewood was of great importance, and is still so in countries deficient in coal or other substitutes and in means of transport. In the more favoured countries the object now is to encourage the greatest possible production of timber, firewood being of small value compared with that of timber. Whether, and to what extent, the demand for wood fuel may increase again in the future, when its substitutes begin to diminish, it is impossible to predict. Under any circumstances, the production of timber is always accompanied by that of a certain amount of firewood.

The proportion between timber and firewood depends on species, rotation and market conditions. The greatest possible outturn of the former has a great influence on the financial success of forestry. In the case of conifers, the percentage of timber can be brought up to 90 per cent., but broad-leaved species rarely give more than 50 per cent. With advancing age, the percentage of timber increases as a rule. Good means of transport make it profitable to export classes of timber which would, in their absence, be converted into fuel. The same holds good as regards the distance between the forest and the market. The conditions of trade and of industrial development generally also influence the percentage of the lower classes of timber which can be disposed of. The more flourishing they are, the higher is that percentage. Generally speaking, the cultivation of species which naturally give a high percentage of timber has for some time been favoured, while that of other species has been reduced; this, and their rapidity of growth, explains the extended cultivation of conifers.

The great increase in the percentage of timber is further due to the fact that new industries have sprung up using wood which formerly was used as fuel, such as the manufacture of wood pulp for paper. Beech, formerly the staple firewood, is now used for furniture, floors, packing cases, pavements, heels of ladies' boots and railway sleepers.

2. Minor Produce.

Apart from wood, forests yield a great variety of produce, such as bark, especially for tanning, turpentine, rosin, rubber, gutta-percha, catechu, numerous other dyestuffs, gums, pitch, tar, oils of various kinds, vegetable fibres, lac, honey, wax, bamboos, canes, leaves, flowers, fruits, seeds, grass, moss, peat, stones, various valuable earths, game, and other items.

In Europe the value of minor produce is sometimes estimated at a low rate, hence the name of minor produce ; but even there some of the items, such as grass, grazing, leaves and litter, are of considerable importance to agriculture, especially in the poorer districts. In many other parts of the world the minor produce is frequently of much greater value than the wood produced in the forests.

Many of the minor products can be obtained without seriously interfering with the production of wood, but in the case of some this is not the case. Of the latter, the removal of litter is probably the most important. Forest soil of poor and even middling quality cannot stand the removal of litter except perhaps once every 6 to 10 years, as the annual removal would exhaust the nourishing substances and deprive it of the protection against injurious atmospheric influences. The result would be a great reduction in the production of wood, if not complete sterility.

Forest grazing is of importance in most parts of the world, and its value is frequently very considerable, whether paid for or given free. If properly regulated, so that areas under regeneration and young woods are properly protected, its effect upon the production of wood is small, but if such protection is not given, great damage and even the destruction of whole woods may be the consequence.

The damage due to the utilization of turpentine differs much according to species and the age of the trees when tapped. Any damage resulting from it should at least be made good by the sale of the turpentine and rosin.

The lopping of trees for fodder is decidedly injurious : except in years of scarcity, it should not be permitted.

To illustrate the relative importance of forest products, an abstract is given of the value of imports into the United Kingdom in 1913, the last complete year of returns before the war :—

IMPORT OF FOREST PRODUCE INTO THE UNITED KINGDOM IN 1913.

	Value.
Timber :	£
Unmanufactured	33,789,000
Manufactured	3,583,000
Wood Pulp	4,618,000
Total Wood	41,990,000
Other Forest Produce :	
Caoutchouc	14,000,000
Gutta-percha	500,000
Cork	1,075,000
Dye-stuffs	600,000
Mirobolans	1,500,000
Bark for Tanning	253,000
Gums of various kinds	1,900,000
Oil of Turpentine	900,000
Rosin	800,000
Galls	80,000
Pitch and Tar	140,000
Vegetable Fibres	800,000
Oils and Fats of various kinds	4,900,000
Valonia	165,000
Total other produce	27,613,000
Grand Total of all produce	69,603,000

It will be observed that the value of imported timber and pulp wood amounted to 42 million pounds sterling, and that of other produce to 27 millions, making a total of 69 millions.

The value of timber used in Europe before the war amounted to more than £200,000,000 annually, and it is more than double that sum now. The quantity of timber consumed in various countries differs very much. Before the war, the annual consumption per head of population amounted in France to 7 cubic feet, in Belgium to 12, in the United Kingdom to 14, and in Germany to 18 cubic feet. On the whole it may be said that in western and central Europe the consumption of timber depends on the degree of industrial development.

SECTION II.—THE INDIRECT UTILITY OF FORESTS.

A piece of land bare of vegetation throughout the year is exposed to the full effects of the sun and air currents and the climatic conditions which are produced by these agencies. If, on the other hand, a piece of land is covered by a growth of plants, and especially by a full crop of trees, it enjoys the benefit of certain agencies which modify the effect of sun and wind on the soil and the adjoining layer of air. These agencies are the following :—

(1) The crowns of a full crop of trees provide a dense roof at a certain distance from the ground which intercepts the rays of the sun and the falling rain, obstructs the movement of air currents and reduces radiation of heat during the night.

(2) The leaves, flowers and fruits, augmented by certain plants which grow in the shade of trees, form a layer of organic matter or humus, which protects the soil against changes of temperature and greatly influences the movement of water and air in it.

(3) The roots of the trees penetrate into the soil in all directions and bind together a loose soil or loosen a too firm soil.

The effects of these agencies have been observed and recorded from time immemorial. In all such cases, however, other agencies were also at work at the same time, and the observations were not always sufficiently accurate and direct to decide in how far the produced effect was due to those other causes. The effect of forests is modified by many matters, such as geographical position, elevation, aspect, gradient, general configuration of the locality, the nature of soil and subsoil, the extent of the wooded area and, last but not least, the composition and density of the forest. Hence, it is difficult to apportion correctly the effect of the different agencies. The consequence was exaggerated confidence and belief on the part of some observers and doubt and unbelief on the part of others. This led in modern times to the commencement of accurate observations, first by Becquerel in France, and Noerdlinger and Krutzch in Germany. A thoroughly practical and conclusive method was, however, not introduced until the year 1867, when Mathieu in France and Ebermayer in Germany started so-called parallel or double stations, one being situated inside a fully stocked forest and the other at some distance from its boundary in the adjoining open country, all other conditions, such as soil, elevation, etc., being as near as possible the same in

both cases. Mathieu started three double stations near Nancy, and Ebermayer seven in various parts of Bavaria. Soon afterwards Switzerland followed with similar stations in the Canton Bern, also Austria, Italy, several other German States, Sweden, Russia and others. The result has been a rich crop of observations.

Although many questions await a final solution, much has been learned which will be indicated in the following pages. In order to concentrate the data, they will be given according to seasons as :—

Spring	comprising	March, April and May.
Summer	,,	June, July and August.
Autumn	,,	September, October and November.
Winter	,,	December, January and February.

1. Effect of Forests on Temperature.

(a) *The Temperature of the Air.*—Observations have shown that forests near the 50th degree of northern latitude slightly reduce the mean annual temperature of the air, on an average by about 1 degree Fahr. as compared with the temperature on open land, the measurements being taken at 5 feet from the ground in both cases. The difference is less in the crowns of the trees ; it is more in mountainous districts than in the plains. Evergreen forests with a dense leaf canopy have the greatest effect, while deciduous thin-crowned woods exercise little effect. Small as the decrease is, it has, as will be shown further on, a decided effect upon evaporation and the preservation of moisture.

Of more importance is the difference during the four seasons of the year. It amounts in spring to 1·24 degrees, in summer to 2·54, in autumn to 1·13 and in winter to 0·61 degrees. The observations further show that the minimum temperature at night and the maximum during the day showed the following increases, +, and decreases, −, as compared with those on open ground :—

	Minimum at night.	Maximum in day.	Range of difference.
Spring . .	+ 0·81 ..	— 3·87 ..	4·68
Summer .	+ 3·15 ..	— 7·42 ..	10·57
Autumn .	+ 2·59 ..	— 4·00 ..	6·59
Winter . .	+ 0·95 ..	— 1·96 ..	2·91
Mean of year .	+ 1·87 ..	— 3·91 ..	5·78

The temperature in forests is higher during the night and lower during the day than on open ground, the differences being most pronounced during summer. Hence, forests tend to moderate the extremes of heat and cold. The effect depends, however, much on the geographical position, the extent to which the localities are exposed to, or protected against, air currents, and on the species. Fully stocked beech woods have, during summer, twice as much effect as spruce or Scots pine woods ; on the other hand, during January, spruce woods have twice the effect of beech woods, due to the dense foliage of beech during summer and its leafless condition during winter.

The reduction of temperature in the interior of forests is communicated to the surrounding country, owing to the continuous interchange of air between the two. To ascertain the extent to which this takes place, a system of so-called radial stations has been established, that is to say, a series of points of observation commencing in the centre of a considerable block of forest and extending at regular intervals into the open country surrounding the forest. In this way it has been ascertained that the effect of forests on the temperature of the air in the open country diminishes rapidly with the distance. If, however, the percentage of forest in a district is very high, the effect may be greater. On this point Dr. Woeikof, late Director of the Meteorological Institute of Petrograd, published some years ago data giving the mean temperature for several series of places, each series being situated as nearly as possible on the same degree of latitude, reduced to the same latitude and altitude above sea level. In this way he obtained the following figures for July and the 50th degree northern latitude :—

Guernsey	59·5	degrees Fahr.
Brussels	62·6	,,
Wuerzburg	68·0	,,
Promenhof	**64·4**	,,
Prague	68·0	,,
Hochwald (Moravia)	**63·7**	,,
Troppau	68·0	,,
Arvavaralji (Hungary)	**64·2**	,,
Lemberg	65·5	,,

Kiew	66·2 degrees Fahr.
Charkow	68·1 ,,
Szemipalatinsk . . .	72·2 ,,

Although there is a steady rise of temperature along this line, reductions occur at Promenhof, Hochwald and Arvavaralji. These three are situated close to extensive forests. The late Mr. Blanford, while Meteorological Reporter to the Government of India, drew a similar line across the gangetic plains into Assam, Sylhet and Cachar, which gave data pointing to similar results. They are interesting, but should be received with some caution, as it is very difficult to assess the effect of other causes, such as exposure to air currents and the presence of sheets of water.

(b) *The Temperature of the Soil* follows that of the air overlying it. The following is an abstract of observations made near the 50th degree northern latitude :—

Differences of Mean Temperature of Soil between Forest and Open Ground in Degrees Fahr.

	On the surface.	1 foot below.	2 feet below.	3 feet below.	4 feet below.
Spring . .	—4·45	—3·33	—3·17	—2·84	—2·43
Summer .	—6·99	—6·71	—6·80	—6·84	—6·64
Autumn .	—2·29	—2·41	—3·02	—3·29	—3·64
Winter . .	—0·20	—0·41	—0·01	—0·00	—0·29
Mean of year .	—4·14	—3·02	—3·24	—3·20	—3·17

The mean annual temperature of forest soil is decidedly lower than that of soil in the open ; in summer by nearly 7 degrees, and very little in winter, while spring and autumn hold intermediate positions. The difference for the whole year is greatest near the surface, but about the same at one foot below and beyond. It decreases in spring from the surface downwards, while it increases in autumn ; it is about the same in summer.

The effect differs considerably according to species. It has been found in Switzerland that the reduction produced by spruce woods amounts to 1·81, that by beech to 3·01, and that by larch

to 2·21 degrees. It has also been found that frost penetrates less deep into forest soil than into soil in the open.

(c) *The Temperature of Trees.*—A point of interest is that the temperature of living trees differs from that of the surrounding air. It is lower by about 2 degrees near the foot of the tree, and by about $1\frac{1}{2}$ degrees in the crown, the actual amount depending on the species.

The data given as regards temperature seem to justify the following conclusions :—

(1) The climate of forest countries is more equable than that of open countries.

(2) The mean temperature of air and soil in forest countries is lower than that in open countries.

(3) Vegetation awakens later in spring in well stocked forests than in the open country.

(4) Plants growing under the shelter of a forest crop are less liable to suffer from late and early frosts, or from drought, than those growing in the open.

2. Effect of Forests on Moisture.

Air can hold only a certain maximum quantity of vapour, which varies with the temperature. When the maximum has been reached and more vapour is introduced, a part becomes condensed. The absolute vapour in the air is measured by its tension upon a column of mercury, as in a barometer. The proportion of the absolute to the maximum tension of vapour, at a certain temperature and pressure, is called the relative humidity of the air. Although the humidity of the air depends in the first place on the general distribution of heat and air pressure over the earth, the vegetation on it also affects it locally. That effect may be felt in the degree of humidity of the air, the amount of precipitation, the degree of evaporation, and in the feeding of springs and rivers.

(a) *Humidity of the Air.*—The observations so far available show that forests have little or no effect upon the absolute humidity of the air ; at any rate the effect is negligible. It is different with the relative humidity. As the temperature of forest air is lower than that of air in the open while the absolute humidity remains the same, it follows that the relative humidity of forest air must

be greater than that of air in the open, more especially in summer. Observations show, near the 50th degree of northern latitude, that the increase in per cent. may amount to 5·70 in spring, 9·28 in summer, 5·22 in autumn and 5·24 in winter, with an annual average of 6·36. There is, however, a decided difference according to altitude; the effect is smaller in low lands and greater in mountains. Further differences have been recorded according to species. Beech acts most powerfully in summer and firs in winter, while the action of pines is considerably smaller. This action of forests explains why dry air currents passing through woodlands become relatively moist, so that precipitations may take place, if not of actual rain, of dew.

(b) *Precipitations, or Rainfall.*—The question whether, and in how far, forests affect the rainfall has been actively discussed for years past. That forests can affect precipitations follows from the facts that their temperature is somewhat lower and their air relatively moister, while the trees mechanically obstruct the movement of air currents; but, on the other hand, the rainfall depends chiefly on other much more powerful agencies, in comparison with which the effect of forests is small. Numerous observations have been made, but those which seem to indicate a decided effect of forests on the rainfall are in many cases of doubtful value. The great difficulty is to separate the effect of forests from other influences. More particularly, elevation above sea level affects the rainfall most powerfully, as air cools on rising, causing increased precipitations, whether there are forests or not. For instance, the observations made at the Prussian stations show an increase of the rainfall in forests as compared with that on open land between the sea and 328 feet elevation of 1·25 per cent., between 328 and 656 feet 14·2 per cent., between 1,969 and 2,297 feet 19 per cent., and between 2,297 and 2,625 feet 46 per cent. It is impossible to accept these effects as being produced by the presence of forests alone. All they seem to show is that at low elevations forests have very little effect upon the rainfall, if any at all, but that their influence becomes considerable with elevation in mountainous districts.

The results of 33 years' observations made at the Nancy stations show an increase of rainfall in the forest equal to 23 per cent. over that in the open ground. Objection may, however, be taken to

these results, because the two stations are not placed at the same elevation, and they are too far apart with the town of Nancy to some extent between them.

Other evidence is available of which the following may be mentioned :—

(1) Ebermayer's observations in Bavaria, started in 1867 and carried out with great care, do not justify any final conclusion as to an increase of the rainfall due to the action of forests. He states that in the plains the effect of forests is certainly very small, but that it increases with elevation.

(2) Extensive observations made in Sweden, on 400 stations during a period of 15 years, show that the difference between parts of the country with 56 per cent. of the land under forest and those with only 17 per cent. under forest is certainly not more than 3 per cent. increase in favour of the former.

(3) The Government of India has during late years investigated the subject, and the results obtained do not justify any direct conclusions beyond the fact that, if forests influence the rainfall at all, the effect is insignificant.

To sum up it may be said that various physical factors act towards rendering forests condensers of vapour ; this faculty is more evident in elevated positions than in low lands and in the vicinity of the sea, where it is swamped by other more powerful agencies. Certainty about these phenomena can be obtained only through further extensive observations.

In connection with this subject it should be mentioned that a forest crop prevents a portion of the rainfall from reaching the ground, because it is intercepted by the crowns of the trees. Light showers may be altogether intercepted, and the water may evaporate before any part of it reaches the ground. In the case of heavy showers or continued rain, a considerable part of the intercepted water will run down the branches and stem. According to observations, the average loss has been estimated at about $\frac{1}{4}$ of the total rainfall, though the actual amount depends on the total rainfall and the species of trees.

The question whether forests reduce the formation of hail has been much discussed. Investigations show that the effect is very small, if it exists at all.

(c) *Evaporation from the Soil.*—Owing to the lower temperature, the greater humidity of the air, and the quieter state of the atmosphere, evaporation is considerably smaller in forests than in the open. This has been conclusively proved by direct observations which have shown that it amounts to a reduction inside forests of as much as 60 per cent. of the amount of evaporation on open ground. In this respect the covering of the soil is of great importance. Ebermayer's observations show that if :—

Evaporation of water in the open is placed at	100	parts.
Evaporation from forest soil, without leaf mould is	47	,,
Evaporation from forest soil with a full layer of leaf mould, is . . .	22	,,

In other words, forest soil covered with a good layer of humus evaporates less than $\frac{1}{4}$ of the water evaporated from soil in the open.

(d) *Summary.*—The above data are general averages. The actual figures for a special locality depend on a variety of conditions such as species, the density of stocking, the temperature and other climatic factors. On the whole, there can be no doubt that forests preserve humidity to a considerable extent. On the other hand, a forest crop consumes a considerable amount of water through the action of the leaves. What that quantity is, has not been definitely determined, nor how it compares with that required by field crops. Ebermayer estimated that a well stocked beech wood consumes a rainfall of as much as 14 inches. Coniferous woods, especially those stocked with pines, require much smaller quantities, while he estimated that required by a crop of clover at 5 inches. In connection with these data it may be mentioned that in India successful cultivation of forests is not possible with a rainfall of less than 15 inches, even with little exacting species. The consumption of water by forest crops causes the soil in the region of the roots to be drier than below it.

Attempts have been made to draw a balance between the water-preserving and water-consuming capacity of forest crops. As far as the available data permit any conclusion, it may be said that, in the plains, forests probably consume more water than they add to the rainfall, or even preserve by reducing evaporation. With elevation in the hills, the reverse may be the case. Hence,

mountain forests have, from time immemorial, been looked upon as the great preservers of moisture.

3. Mechanical Effect of Forests.

The mechanical effect of forests makes itself felt chiefly with regard to the distribution of the rain water, the preservation of the soil on sloping ground, the binding of shifting sand, the prevention of avalanches, the moderation of air currents and the aeration of the soil and subsoil.

(a) *Feeding of Springs and Rivers.*—Most of the rain-water falling on a bare slope rushes down into the nearest watercourse in a comparatively short time, thus causing a rapid rise in the level of streams. Only a comparatively small portion sinks into the soil and becomes available for the feeding of springs. Of the rain falling over a forest, close on one-fourth is intercepted by the crowns of the trees, and the other $\frac{3}{4}$ fall upon a layer of humus which possesses a great capacity of absorbing water and of retaining it for a time. It has been shown, for instance, that mosses of the genus *Hypnum*, which grow under the shelter of conifers, can absorb up to five times their own weight of water, and peat mosses of the genus *Sphagnum* up to seven times, while the leaf mould found in a middle-aged well-preserved beech wood can absorb and retain for a time a considerable quantity of water. Some of that water evaporates from the soil covering, but the greater part penetrates into the soil ; some of it is taken up by the roots, and the balance becomes available for the feeding of springs. In this manner well-preserved forests have a decided effect upon the sustained flow of springs.

The interesting point is to determine the proportion of the annual rainfall which actually reaches the under-ground water level. The problem is very complicated, as its solution depends on a great variety of factors, such as the amount of rainfall and its distribution over the different seasons of the year. It should also be remembered that about one-fourth of the rain is intercepted by the leaf canopy, and in the case of a light shower every drop of it may evaporate and never reach the ground. In this respect the species of tree causes great differences. Of the ordinary European trees the firs retain more water than the pines or the deciduous broad-leaved species. On the whole, the view

has been expressed that on level ground less water reaches the underground water reservoirs in forests than in open ground. In so far, forests would act unfavourably as regards the feeding of springs. On hilly ground, however, a smaller proportion of the rainfall rushes straight away into the water channels in forests, giving the rest time to infiltrate into the soil. Observations made in the Russian Steppes and in Northern Russia indicate that the water level was lower in forests than outside. Similar results were obtained in France. On the other hand, observations made in Bavaria, Alsace and Switzerland have shown that no general rule can be laid down on the subject. As a matter of fact, the underground water level depends chiefly on the nature of the geological formation, that is to say, on its permeability. The configuration of the ground also causes great differences.

The above considerations govern also the water level in rivers, in so far as forests retain a large portion of the falling rain, if not permanently, at any rate for some time, thus enabling rivers to spread the discharge of their water over a longer period of time, resulting in a reduction of the flood level.

When the forest humus has been saturated with water, and rain continues, its effect as regards inundations must cease, because the additional water follows the law of gravitation and finds its way into the valleys. Hence, these effects are of limited extent, a matter which has been frequently overlooked. To moderate inundations to any appreciable extent, it is necessary to keep a very large proportion of the catchment area under forest. On the other hand, well-stocked catchment areas produce a steady flow of water during the dryer part of the year, and thus keep up a higher level in rivers at these seasons for the supply of water for irrigation and other purposes.

(b) *Protection of the Soil.*—Water rushing down a bare hillside possesses a great mechanical power, by means of which it loosens the soil and carries it downhill. In this way landslips are frequently caused, ravines formed, and fertile lands at the foot of the ravines covered with silt and rendered useless. Frequently the debris collects in the rivers and forms obstructions, which are followed by a diversion of the bed and erosion of fertile lands. The rate at which this damage proceeds depends on the geological formation and the formation of the surface ; the less binding the

soil and the looser the formation, the greater will be the damage. If, on the other hand, such a slope is covered with a well-preserved forest, the roots of the trees and the layer of humus keep together and protect the soil against the action of water; besides, the crowns intercept and retain, at any rate for a time, a considerable portion of the water. On the whole, a series of obstacles are opposed to the movement of the water, which reduce its velocity and force it into numerous small channels, thus dividing it. The beneficial effect of tree vegetation in this respect can be observed in most mountain ranges, as in the Alps from France to Austria. Wherever in these parts extensive deforestation has taken place the consequence has been the gradual formation of a series of torrents in all places where the surface did not consist of hard rock; the debris brought down has covered more and more land at the base of the torrents, and this evil had grown to such an extent that efforts have been made to re-afforest the denuded areas at a great outlay. In such cases, afforestation had to be preceded by the construction of dams, dykes, walls, etc., to steady the surface, to enable the new forest growth to establish itself and once more to lay hold of the surface soil.

The importance of maintaining a complete cover of vegetation in all such cases was recognised centuries ago, so that already in the Middle Ages so-called "Protection Forests" existed, which the then existing laws protected against devastation.

Forests protect the soil also in low lands, wherever it consists of shifting or moving sand, along the sea shore as well as inland. The action in this case is due, partly to moderating the force of air currents, and partly by keeping the soil together through the action of the roots, by the formation of humus and the retention of moisture. Along the sea-coast frequently artificial dunes have to be constructed before afforestation can be attempted. In this way the Landes of France have been converted from a dreary waste into extensive forests, fields and vineyards.

(c) *Protection against Avalanches.*—Although most avalanches in the higher mountains originate above the upper limits of tree growth, there are many cases where the presence of a well-preserved forest protects towns and villages lying below, by preventing the formation of avalanches, or by stopping their forward movement while they are still small. When they

have reached some size, however, even forests will not stop them.

(d) *Protection against Air Currents.*—Forests break or moderate the force of air currents and in this way afford protection to lands lying beyond them against cold or dry winds. They also afford shelter to cattle, game and useful birds. Their importance in this respect should not be overlooked. The presence of birds, the great enemies of injurious insects, depends often on that of woodlands, though in this respect hedgerow trees are equally, or even more, effective.

(e) *Aeration of the Soil.*—This is a large subject which cannot be dealt with in this place; but it should be mentioned that the action of the root system of trees takes part in enabling air and water to penetrate into the soil, more particularly in the case of binding soils and subsoils.

4. Influence upon Hygiene, Æsthetics and Ethics.

Forests, as part of the vegetation of the earth, take their share in keeping a proper balance of carbon dioxide in the atmosphere; they dissect it, keeping the carbon and setting free oxygen; the process is reversed when wood is burnt or decays.

Observations appear to show that forest air, like sea air, is much richer in ozone than air in the open country and especially in towns. Ebermayer, who made extensive observations, found up to five times as much ozone in the forest as in the manufacturing town of Zwickau. He found the greatest difference during winter, which seems to show that the presence of ozone does not depend on the action of the leaves. French investigators have further ascertained that the number of bacteria in forest air is only a fraction of that found in Paris air.

Based on observations of these kinds it has been asserted that forests have a considerable influence in counteracting disease. Instances are not wanting where forests are said to have given protection against the germs of malaria, but there are others in which they are believed to have had the opposite effect. However that may be, the author is inclined to think that any beneficial effect of forest air is chiefly due to the absence of smoke, dust and injurious gasses and, above all, to the greater tranquillity of the human mind, free from worry while in rural parts of the country.

The æsthetic and ethic effect of forest life and scenery should not be overlooked. The ever-increasing growth of towns and of industries demand periodic changes from such centres to more invigorating conditions. They have been found in continental countries in forest-clad districts, while in the British islands visits to the seaside have been the more general rule. The latter are often practicable only for the wealthier classes; for the poorer classes forests situated within a short distance from the towns are of real importance. They can be reached in a short time and at small expense, and experience has proved that such visits have a most beneficial effect upon the working classes. Visitors to Paris have, no doubt, seen masses of working men, with their wives and children, stream into the Bois de Boulogne with their luncheon or tea baskets. In the same way, the people of Brussels go to the Bois de la Cambre and the adjoining Forêt de Soignes. The importance of Epping Forest to the East End of London is well known. We are now in a period in which the welfare of the working classes is a prominent item of politics; and part of it is to make their life more enjoyable than it has frequently been in the past. The Forestry Commissioners entrusted with the realisation of the new afforestation scheme should not overlook this matter, but see that woodlands are provided in the vicinity of large towns, whenever land can be secured on reasonable conditions. Municipalities and county councils should give active assistance in this direction. Such woodlands will not only serve as recreation grounds for the people, but their produce will find a ready sale at good prices, so that their establishment under rational treatment need not be a financial burden.

SECTION III.—SUMMARY OF CONCLUSIONS.

The various ways in which forests exercise an influence in the economy of man and of nature may be summarised as follows:—

(1) Forests supply timber, fuel and a variety of other produce.

(2) They offer a convenient opportunity for the investment of capital and the profitable utilization of inferior land.

(3) They produce a demand for labour in their management and working, as well as in a variety of industries which depend on them for raw materials. (See next Chapter.)

(4) They reduce the temperature of the air and soil and render the climate more equable.

(5) They increase the relative humidity of the air, reduce evaporation and maintain a more continuous degree of moisture in the soil.

(6) They tend to increase precipitation of moisture.

(7) They assist in regulating the water supply, produce a more sustained feeding of springs, reduce violent floods and render the flow of water in rivers more continuous.

(8) They assist in preventing erosion, landslips, avalanches, the silting up of rivers and low lands, arrest shifting sands, consolidate too loose soils and assist the aeration of too firm soils.

(9) They reduce the velocity of air currents, protect adjoining fields against cold or dry winds, and afford shelter to cattle, game and birds.

(10) They increase the artistic beauty of a country, may, under certain conditions, increase its healthiness, and at any rate have a beneficial effect upon the human mind.

(11) Forests render considerable assistance in the defence of a country.

CHAPTER II.—THE FACTORS OF FOREST PRODUCTION.

In forestry, as well as in the cultivation of field crops, the factors of production may be arranged under three heads: Natural Forces, Capital and Labour.

1. Natural Forces.

They are represented by :—

(*a*) The chemical and physical properties of the soil; and

(*b*) The climate, which depends on the geographical position and the local conditions governing the intensity of the sun's rays, and the condition of the atmosphere generally.

The summary of these forces is in forestry called the "locality."

The extent to which they exercise their effect determines the "yield capacity" or "quality" of the locality.

(a) *The Action of the Soil.*—While the carbon required by trees is principally taken from the atmosphere, the soil provides the mineral substances and the water required for the formation of wood. These are of the same kind as those required by field crops, the most important being potash, lime, magnesia, and phosphoric acid. As regards quantity, it has been proved that an average forest crop requires only about one-half (54 per cent.) of that necessary for an average field crop. The greater part (46 per cent.) of the mineral substances is deposited in the leaves, and, if these are allowed to decay in the forest, their mineral substances are returned to the soil, so that only about 8 per cent. are removed with the wood. Consequently, exhaustion of the soil is much slower if used for forestry than for the production of field crops; on the contrary, an improvement of the yield capacity may take place under careful forest management without artificial manuring.

Whether, and to what extent, the nourishing substances in the soil become available for the production of wood, depends on the physical properties of the soil, such as its degree of density, the extent to which heat and moisture are retained, and its depth. The latter is essential for the development of a sufficient root system, and it improves the physical properties generally. On the degree of density depends a proper aeration of the soil and the retention of moisture and heat. In this respect, the presence of a suitable layer of humus is of great importance; it loosens a too firm soil and binds a too loose soil, in either case improving the fertility.

(b) *The Action of the Climate.*—The productive action of the chemical and physical properties of the soil is possible only if the climatic conditions correspond with the requirements of the species of trees which it is proposed to grow. In addition to a sufficient rainfall, a certain minimum of heat is necessary, both as regards the average temperature of the year and that of the growing season. The degree of heat also influences atmospheric precipitations.

The temperature of a locality is determined by the geographical position, the elevation above sea level and other local

conditions, such as exposure to, or protection against, cold or strong air currents, the aspect and slope of the locality. Generally, trees do best in the centre of their natural distribution, which may be called their " optimum." Towards the limits of the distribution area, whether it is approached by increasing latitude or rising in the hills, growth decreases until it ceases. Even too high a temperature, though it may stimulate production, is not favourable in the long run.

2. The Capital of Forestry.

The capital of forestry consists of : (1) permanent works, such as buildings, means of transport, as permanent roads, forest railways, timber slides, wire tramways ; (2) the soil ; and (3) the growing stock. The part mentioned under (1) represents in some cases a considerable capital, but in the majority of cases it is of comparatively small amount if compared with the value of the soil and growing stock. The latter two represent the main part of the forest capital. The soil is called the " fixed," and the growing stock the " shifting," or " movable," capital of forestry.

In the case of a single wood of even, or approximately even, age, the capital represented by the growing stock is small while the wood is young, but it increases with advancing age. It disappears when the wood is cut over, and it is built up again by the accumulation of successive annual increments produced by a new crop. When the forest consists of a number of woods and the management aims at the realisation of a sustained and approximately equal annual return, the growing stock must consist of a series of age gradations, or age classes, of which the oldest is cut annually or within a limited number of years and replaced by new increment. Hence, there is the same amount of growing stock permanently in the forest called the " normal growing stock."

The proportion between the value of the soil and that of the normal growing stock depends on the species, the method of treatment, the length of the rotation and the yield capacity of the locality. In coppice woods the fixed may be greater than the movable capital, but in high forest, where the object is to produce timber of some size, the growing stock is usually of considerably greater value than that of the soil, and under a high rotation the proportion between the two may be as much

as 10 to 1 and even more. If, under such conditions, forests yield a higher return than, for instance, that from field crops, it depends on the rate of interest used in the calculation whether the one or other method of utilising the soil is the more profitable. Generally speaking, good land yields a higher percentage on the invested capital under agriculture, and inferior land under forestry. Although, therefore, forest soil is ordinarily of much smaller value than agricultural soil, under the system of a sustained annual working the forest capital is frequently of greater value than that required for agriculture. In any case, the interest on the capital forms part of the cost of production, and the forester must make sure that any increase of the permanent capital is justified by a corresponding increase in the yield. The deciding element is the length of the rotation. The higher that is, the greater will be the growing stock for the same area, and consequently the cost of production. The net income culminates under a certain rotation, beyond which it diminishes. Other considerations may justify the adoption of a higher rotation, such as, for instance, the production of a special class of produce required for a particular purpose, or the necessity of keeping a certain stock of timber in the country to safeguard it in case of an emergency.

The value of the soil or the growing stock can be ascertained as the cost—expectation—or market value. In the case of the sustained annual working, the value of the growing stock is obtained by capitalising the net annual income and deducting the value of the soil. The details of the calculations are given in Forest Valuation.

3. Labour in Forestry.

Forests require labour in a variety of ways, which may be brought under one of the following three headings :—

(1) General administration and management, including formation, tending and harvesting.

(2) The transport of produce.

(3) Industries which depend on forestry for their raw material.

The quantity of labour required under the first heading depends chiefly on the intensity of management and the quantity and value of the produce ; in other words, on the care bestowed upon

the treatment of the woods and the yield capacity of the locality. In a general way it may be said that in Britain 4 days' labour are annually required for every acre of systematically-managed forest. This would represent about one-tenth of the labour required per acre of field crops, but about ten times that required in the case of light grazing on mountain and heathland. Very little of the labour here under consideration can be replaced by the use of machinery except in the case of clear felling of areas of some extent.

The transport of forest produce is a business of considerable magnitude, as that produce is very bulky. It is carried by water whenever possible, as that is the cheapest method of transport. For land transport in the forest and in its vicinity, roads are, under ordinary conditions, the most suitable means, because by them not only the material obtained from final cuts, but also that of the periodic thinnings can profitably be moved. Moreover, roads serve as divisions between blocks and compartments and as fire lines ; finally, they are indispensable for communication and the proper control of operations. In the working of extensive areas additional means of transport may be indicated, such as railways, tramways, wire tramways, timber slides, &c. Such establishments will, however, not be financially successful unless large quantities of produce are carried over them. It has been estimated that the amount of labour required for transport comes to about half that necessary for administration and management.

In forest industries labour is required to work up the raw material yielded by the forests. Its amount is at least double that required in administration, management and transport put together. It includes labour required in saw-mills, house construction, shipbuilding, carpentry, and in a large variety of other industries, some of which can exist only in or near forests.

No accurate statistics showing the actual amount of labour required in various countries under the above three headings are available, but it may be mentioned that in Germany such labour is estimated to occupy 12 per cent. of the total population of the country.

An important point is that a great part of the work is independent of the season of the year, and that it can be done when work in other industries is slack, especially in agriculture.

4. Effect of the Factors of Production.

Natural forces, capital and labour produce effects according to the proportion in which they are applied to a locality. Under the action of natural forces only, the effects are generally of moderate intensity; with the addition of capital and labour the intensity of management increases. Accordingly, a considerable number of methods of treatment, or silvicultural systems, have been evolved in the course of time, their intensity increasing in the proportion of capital and labour being added to natural forces.

The most primitive form is that represented in primeval forest, where some trees are cut for utilization, while others die, are thrown by wind, or killed by fire or disease. The restocking of clear spaces is left to nature. Gradually man took steps to regulate the selection of trees to be cut with a view to assisting and accelerating regeneration by natural means. Thus what is known to foresters as the regulated "Selection System" came into existence.

Further changes were introduced with a view to concentrating the work on one part of the area at a time and to separating the age classes and establishing them on separate areas, leading to the system known as the "Compartment or Uniform System." Subsequently the annual or periodic *coupes* were further reduced to strips or to groups, known as the "Strip and the Group Systems." In all these systems regeneration may be by natural or artificial means, or by the two combined.

A different method is that of "Coppice Woods," where regeneration is effected by shoots which spring from the stools after the wood has been cut over. The system is applicable only to species which produce a full crop of stool shoots or root suckers. By combining the coppice system with seedling forest, a combination system is produced known as the "Coppice with Standards System" (or stored coppice).

The desirability of the several systems depends on local conditions and the objects which the proprietor has in view. When small material is required, the coppice system may be indicated; where also a limited amount of timber is required, the coppice with standards system may be adopted; when the largest possible quantity of high-class timber is wanted, one

of the high forest systems with either natural or artificial regeneration would be the best. Again, a proprietor may be satisfied with intermittent returns, or he may aim at a sustained annual yield of approximately the same amount. Accordingly, the several methods differ much in intensity. The uniform system of high forest or one of its modifications, aiming at a sustained annual yield, is generally the most intensive, and it should give the most favourable financial results. On the other hand, it requires the greatest capital, more labour, and the most intelligent management on the part of the forester. To what extent extra outlay is justified depends chiefly on the yield capacity of the locality. If its fertility is fairly good, the employment of increased capital and labour will, as a rule, be justified, but frequently not so on localities of inferior yield capacity. Outlay and results must be in due proportion ; in other words, additional outlay is justified only if it results in an adequate increase of the return, either in the form of quantity or quality of produce or in some other form, according to the proprietor's aims and objects.

The private proprietor will, in the majority of cases, adopt that method and degree of intensity which gives him the highest net revenue, or rather the highest interest on the invested capital ; the State, on the other hand, has frequently to consider the interests of the community as a whole and to aim at other results which may reduce the financial net results, such as, for instance, to keep a certain stock of timber in the forest to meet special emergencies, or to produce certain indirect effects. Considerations of this class frequently lead to a degree of intensity below that which is indicated by the yield capacity of the locality. The difference in the results thereby produced must be accepted as the loss incurred by the realisation of the special objects.

5. Forestry and Agriculture Compared.

Forestry, being based on the yield capacity of the land, competes with a variety of other industries similarly situated. In most cases it has to give way for financial and other reasons. The case which interests the forester specially is that of " forestry *versus* agriculture proper." Even in that case agriculture demands first consideration, because it produces food for man and animals, whereas forests produce chiefly cellulose and acces-

sory produce. And yet, under certain conditions, forestry may be more desirable than agriculture. What these conditions are will be indicated in the following remarks :—

(1) Foodstuffs cannot be produced in profitable quantity and for any length of time without manuring and intense working of the soil so as to produce and maintain those physical and chemical conditions which are essential for obtaining a full crop. Field crops must be cultivated in rotation, because different crops make different demands on the more important nourishing substances in the soil. Trees are far less exacting in this respect, especially as regards the rarer and more important mineral substances ; moreover, trees with their deep-going roots possess the faculty of procuring mineral substances from the subsoil, which would not be accessible to ordinary field crops. For these reasons forestry can be successfully carried on without manuring in localities which are unfit for the cultivation of field crops. As a consequence, the more fertile lands are allotted to the cultivation of field crops, and forestry must generally be satisfied with the poorer classes of soil, the rougher climates, and the slopes in hilly localities. Only grazing grounds may compete with forestry in such cases, and it depends on local conditions whether the one or other is preferable. Only little exacting species of trees can be grown on mountain and heath lands in Britain to begin with, such as pines. They can, however, be followed by more exacting species when the soil has been improved by continued protection and the accumulation of leaf mould.

(2) In forestry the proprietor has to reckon with long periods of time, and newly created forests do not yield a return until after the lapse of a considerable number of years. The length of that period depends on a variety of conditions, such as the species, the yield capacity of the locality, and the method of treatment. In a few cases, as in the culture of willows for basket work, returns may begin after a year or two, but such cases form a very small percentage of the whole. In other coppice woods returns may commence after about 8 or 10 years, and in the case of timber production thinnings do not commence until after 15 to 30 years, according to species, the first thinnings being generally of small value. Final cuttings in timber forests rarely come earlier than after 40 years, and they may take 100 and more years. In

agriculture, on the other hand, returns are received within a year or so from starting.

(3) Owing to the delay in returns, the expenses incurred in starting forests are accumulating with compound interest until they are recouped by returns, and, as a result, forestry does not yield a high interest on the invested capital. In a general way it may be said that agriculture is more remunerative on good land and forestry on inferior land. The latter may, on financial grounds, be called " forest land." Foresters distinguish between absolute and relative forest land. By the former is understood land which is absolutely unfit for profitable cultivation with field crops or where forest must be maintained for the benefit of the community as a whole ; relative forest land means land of better quality which would yield better results under forest than under field crops. The limit between the two is not easy to determine, nor is it a fixture, as it may change with altered conditions.

(4) The weather, natural phenomena, animals, fire and other sources of danger threaten the produce of the land. In the case of field crops the produce of only one or a few years at a time is exposed to such danger, but in forests the whole of the growing stock, that is to say, an accumulation of many years' produce, is liable to be affected. On the other hand, a forest crop is, as a rule, less susceptible to damage than the more tender field crops. The greatest dangers of a forest crop are those from fire, insects, fungi, storms, snow and rime. Damage by these agencies can, however, be kept within narrow limits by careful management.

(5) Timber and fuel are bulky articles which do not bear transport overland to the same extent as the more valuable classes of field crops ; hence, forest produce must be grown within a limited distance from the place of consumption, unless water carriage is available.

(6) The danger of trenching on capital is much greater in the case of forestry than in other industries, because the more valuable part of the capital consists of the growing stock, that is to say, material of the same class as that of which the legitimate annual yield consists. An unscrupulous or ignorant forester can consume a considerable part of the capital in the shape of annual incomes without detection or even without becoming aware of it ; hence, the importance of a reliable and competent staff. In this respect,

it is of great importance that the thinnings are made in the right way, as too heavy thinnings may disastrously affect the final returns. As a consequence forests are not always suitable as security for loans, nor fit objects for leasing.

(7) Forests more than other lands are burdened with rights and privileges belonging to third parties, such as the right to take produce from the forest or to use the land for grazing cattle on it. These rights usually interfere much with the management and usefulness of the property.

(8) As forest work is to a great extent independent of the seasons of the year, it can be combined with agricultural work. In many civilised countries a deficiency of agricultural labourers has become very pronounced. The deficiency has partly been made good by the introduction of machinery, but that has not met the whole case. It is here that forestry can help. The bulk of forest work can be done between late autumn and early spring, when work in the fields is at a minimum. Consequently, a larger number of agricultural labourers will be available from early spring to late autumn, if the same men are also employed on forest work during winter. By developing an arrangement of this kind on estates both agriculture and forestry would benefit. The system is of special usefulness in providing healthier conditions in districts like those of the Scotch Crofters. By afforesting part of the area, work is provided for the crofters during winter, which will enable them to live more comfortably than if they have to rely on their small holdings only. It is also useful to small holdings generally, provided the forests are distributed over the country in blocks of suitable size. As long as each block is large enough (say 500 acres and upwards) to make it worth while putting a man in charge of it, it can profitably be managed for a sustained yield.

All these points should be considered in allotting the land to agriculture and to forestry respectively.

CHAPTER III.—THE STATE IN RELATION TO FORESTRY.

1. Duties of the State Generally.

It is the duty of the State to make laws which, on the one hand, afford sufficient latitude to the individual for personal activity and development, and, on the other hand, prevent his interference with the activity of his neighbour. In the majority of cases, the State must also make laws for the purpose of subordinating the interests of the single individual to the joint interest of the community as a whole, whenever the two clash. The nature of such laws depends to a considerable extent on the degree of education, the moral sense and the customs of the people.

The action of the State must frequently also aim at directly *furthering* the welfare of the people, by removing obstacles which obstruct the action of the individual, or by creating institutions which strengthen his working power. Such cases occur when the power of the individual is not sufficient to attain objects which are essential for general development; when the advantages to be derived are not sufficient to induce individuals to take up the task; when the action of the individual endangers the interests of the community; and generally when it is preferable that the State should guard the interests of the community in cases where permanent institutions must be made independent of personal interests, fancies and wishes. In such cases the State alone affords sufficient guaranties for continuity of action in a given direction.

From the above remarks it will be seen that there are certain matters of general interest which are better kept under the care and management of the State, while others may be left to the free action of the individual. The limit between the two classes is by no means easy to draw, nor can it be fixed permanently; it depends on the degree of civilisation and the character of the people, the economic condition of the country, and on political events.

Applying now what has been said to the case of forestry, it follows that the State must interfere, sometimes *limiting* and sometimes *furthering*, whenever the welfare of the community

demands it ; beyond that it should not go. The nature and extent of the measures depend on the special conditions and requirements of the country, and especially on the safety and facility of obtaining a sufficient quantity of forest produce from outside in all cases where the forests of the country are not of sufficient extent to provide it. Under any circumstances, every effort should be made to safeguard the country in the case of an emergency. Matters differ in various countries in this respect. In some countries no State control is as yet exercised ; in others it is restricted to " protection forests " and to State forests ; in others it is extended to corporation forests, and in others even to private forests.

The control of the State over forests, whatever the proprietorship may be, must be regulated by law. In some countries such laws are incorporated with the general laws ; in others special forest laws have been passed.

2. State Forests.

There are few countries in which the State or the Crown does not own forests. As a rule, such forests were originally at the disposal of the ruler of the country, but by degrees they became in most cases the property of the State, forming an important part of the national property. On reference to the data given on page 42 it will be seen that the percentage of State forests ranges from 66·4 per cent. in Russia to 2·4 per cent. in the United Kingdom. In India the whole of the soil was, in Akbar's time, considered the property of the Emperor ; subsequently large areas were surrendered to communities and private persons, so that at present only about 70 per cent. of the existing forest area belongs to the State.

As the State appears in this respect in a double capacity, namely, as the power which lays down the general forest policy of the country and also as the proprietor of part of the forest area, the question may naturally be asked whether it is desirable that the State should continue to possess forests in its own country, or whether the forest industry should be altogether in the hands of private persons ? It has been asserted—

(1) That it is below the dignity of the State if the Government and private persons compete in the open market.

(2) That the State cannot manage forests as profitably as private persons.

(3) That State domains act injuriously, because they interfere with the development of industries and reduce the opportunity for paying enterprise on the part of private persons.

These arguments possess, no doubt, some weight, but much can be said on the other side. As regards the first argument, a great change has taken place during recent years: the State is now called upon to interfere in so many directions with commercial matters that the addition of forestry cannot make much difference, if any. As regards the second point, there are many cases to prove that the State has managed forests as profitably, and even more so, as private proprietors. With reference to the third objection, it must be pointed out that the objects of the two parties differ. In economic forestry the object of the private proprietor centres generally in the realisation of the greatest profit; the State, on the other hand, considers the interests of the community as a whole. It has to take note of other requirements besides pure financial results, such as the production of a special class of material or the realisation of indirect effects of forests. Again, forest crops take a long time to mature, and continuity of action is an essential matter in economic forestry. This can, in the majority of cases, be secured only by the State; it must make sure that a sufficient quantity of produce of the required kind is provided, and in many cases from the smallest possible area, so as not to interfere with the production of food or with the utilisation of land for other important purposes. Again, forestry can be profitable only if conducted on a fairly large scale, which requires a large capital, such as is not always at the disposal of private persons. It is essential for the production of a steady, lasting supply, without which no regular market can be secured. It may also happen that in the case of emergencies, as happened during the late war, the necessary requirements of timber for the conduct of the war, for construction and industries, especially for coal mines, are not forthcoming. In such cases State forests represent a reserve which can be drawn upon.

In summing up, it may be said that, on the one hand, not all forests need be State property, and, on the other hand, that, in

the majority of cases, a wise administration will keep in its own hands a certain percentage of the forests. What that percentage is depends on the special conditions of each country.

The system of management to be applied to State forests should be that which secures to the country the greatest possible advantage, whether it be represented by high financial returns or by other important considerations. As forests represent capital, their management should, in the first place, be determined by financial considerations, but the management thus indicated should be modified in so far as other considerations may demand. The financial loss thereby incurred represents the amount to be paid for the realisation of special objects.

3. Forests of Communes and other Corporations.

By a commune is here understood a group of persons enjoying the rights of a juristical person. Communes may hold joint property, of which forests frequently form an important part.

Communal forests have been originated in various ways, such as purchase, gift, planting of communal lands, or by prescription. The Indian forest law provides for the allotment of Government land to communes to form village forests. Corporation forests have been established by the afforestation of the catchment areas of water works. Epping Forest was made over by the State to the City of London.

The returns from such forests benefit the members of the community, either by the receipts going to the communal exchequer to defray the general expenses of the community, or the yield in material or cash goes direct to the members of the community. In the latter case, the right of participation may be attached to personal membership or to the possession of land or a house.

In many countries the communal forests amount to a considerable portion of the total forest area: in Switzerland to 67 per cent.; Hungary, 52 per cent.; Italy, 43 per cent.; France, 23 per cent.; in Germany to 19 per cent.; and in Austria 18 per cent. Although communes should have a large measure of liberty in managing their affairs, in regard to their forest property a certain amount of supervision on the part of the State is frequently indispensable for the following reasons:—

(1) The personal interests of the members of the commune are likely to injure the sustained yield of the forests; the poorer members especially urge more extended utilization than the forests can stand permanently.

(2) Communes which are in debt or propose special works, such as the construction of roads or communal buildings, are inclined to meet their liabilities by overworking the forests. To meet this difficulty the French law lays down that 10 per cent. of a communal forest is to be kept in reserve.

(3) The forests of communes are not always of a sufficient extent to secure a competent manager for them at a reasonable outlay.

(4) The maintenance of communal forests tends to consolidate communal life, especially in small communes such as villages, which, in many cases, meet all expenses with the receipts from the forests.

The manner and extent of State control depend on the constitution of the commune and on the degree of political education of its members. In the case of towns, supervision by the State is less frequently necessary than in the case of rural communes. It is of importance that supervision should not go beyond what is really required. It suffices to ensure that the forests shall be managed economically and their yield capacity not reduced. The State supervision differs much in different countries. In some cases it suffices to prohibit devastation, the sale or division of the forests, their conversion into fields or meadows without previous sanction in each case. In other cases, the State insists on the forests being worked in accordance with previously approved working plans.

In various countries the communal forests are managed by Government forest officers in the same way as State forests. Where the forests of a commune are not large enough to occupy a fully competent manager, they are managed together with those of neighbouring communes, or with State forests. This method of management has yielded excellent results. It is essential that in all these cases the communal authorities co-operate with the manager. The disposal of the yield is, as a rule, left to the commune, and also the appointment of the subordinate staff subject to the approval of the supervising authority.

Forests belonging to endowment funds, universities, &c., are in some countries treated as communal and in others as private forests.

4. Private Forests.

The question whether private forests should be subject to State supervision, and if so, to what extent, has been much discussed. It is said that amongst the general duties of the State is included the obligation of seeing that articles necessary for the welfare of the people are forthcoming, and that the forests are suitably distributed over the country. Wood, it is said, is an important article of consumption which is absolutely necessary. Private persons, it is argued, cannot estimate the total requirements of the country, nor arrange the management of the forests accordingly. It is further said that the economic means of private persons are not sufficient to meet the case, and that such persons frequently have not the necessary knowledge for conducting a systematic management. Moreover, the returns of forestry occur so late that he who sows rarely reaps ; hence, private owners are inclined to favour their own momentary interests to the disadvantage of future generations by over-cutting their forests. The consequence might be overstocking of the market at one time and a deficiency at others. All this tends towards the conclusion that State supervision may be necessary.

The argument on the other side is somewhat on the following lines : " There is no reason to consider the forest industry as differing from other industries ; the best guarantee for a reasonable management is the prospect of an adequate profit. Should an owner not be able to realise that, the forests would be sure to pass into more capable hands. The supply of forest produce would be regulated by the demand, and prices established accordingly. The fear of a wood famine is unnecessary, because it would not come suddenly, so that it could be met in time. [The fallacy of this argument has been proved by the late war, and similar emergencies may occur again.] State supervision is mischievous, because even the State is not always able to determine future requirements. As a consequence, State interference in this direction is liable to be harsh and unjust ; it destroys the desire of private owners to take up forestry. Instead of obstructing private forestry in this manner, the State should stimulate it by

removing all obstacles to it, such as facilitating the construction of means of communications, providing good laws for the protection of forest property, the commutation of forest rights, and advances to planters at rates of interest equal to that at which Government can borrow money. If that is not successful, the State should acquire a sufficient area of forest to safeguard the welfare of the State. At any rate, private forestry should be free of State interference, whenever the State and communes possess already a sufficient area for the purpose of guarding against an emergency."

In the United Kingdom the area of State forests is very small, and there are, as yet, few communal and corporation forests, while there is no interference with private forests except in the case of settled estates. In the latter case, timber (which means oak, ash and elm) is under control, so as to prevent present holders utilizing more than their proper share. The case of the United Kingdom is exceptional, owing to its favourable position as regards imports of timber and the available substitutes for firewood, excepting always sudden emergencies.

In continental countries conditions are less favourable. In most cases the means of transport are less developed, and the quantities of substitutes for wood smaller. There, the State is called upon in many cases to interfere in the interest of the common welfare. In Prussia, where the State and communal forests amount to 51 per cent. of the total forest area, private forests are free from supervision, but in most other German States they are under a certain amount of control. They are also under control in Austria, Hungary, France and Switzerland. They are partially under control in Italy, Sweden and Denmark. These remarks do not refer to " Protection Forests," which will be dealt with below.

The measures provided for the supervision of private forests partly tend towards an increase in the quantity and quality of forest produce, and partly guard against extravagance in the consumption of such produce. They refer to :—

(1) Prohibition to convert forests into fields or meadows, or to use them for other purposes, without permission.
(2) Compulsory afforestation of certain lands.
(3) Prohibition of devastating existing forests.

(4) Rules for the management of existing forests.
(5) State management of private forests, if necessary.
(6) Prohibition of dividing or selling private forests.
(7) Regulation for the use of forest produce.

The establishment and maintenance of private forests should be encouraged; hence, the measures of control should be reduced to the smallest possible minimum, and this should be imposed only when absolutely necessary in the interest of the community as a whole.

5. Protection Forests.

By Protection Forests in the present sense are understood forests which must be maintained on account of their influence upon natural phenomena and their effect upon climate. Such forests may be the property of the State, communes, other corporations, or private persons. The law of the country should provide for their formation if they are required for purposes like the following :—

(*a*) The preservation of the soil, especially on hillsides, so as to prevent erosion, denudation, landslips, the formation of ravines, the silting up of fertile land at the foot of the hills and the extension of shifting sands.

(*b*) Preservation and regulation of the water supply in springs and rivers, so as to secure an even flow and prevent floods, the supply of water for irrigation, the reduction of evaporation, and the prevention of the defilement of the water in catchment areas.

(*c*) Protection against injurious air currents, such as gales, hot or cold winds.

(*d*) For the benefit of the public health.

(*e*) For the prevention of avalanches.

(*f*) For the defence of the country.

Protection forests may be made subject to special regulations as regards the manner of cutting and working generally, the execution of planting or sowing, the construction of accessory works, such as dams, weirs, erection of fascines, fixation of shifting sands, the regulation or prohibition of cattle grazing, the removal of litter and similar matters.

The procedure followed in declaring protection forests differs considerably in the various States; in some, a selection of such forests has been made, in others they are declared from time to

time as necessity arises. Before the State is justified to interfere, and thus to impose restrictions in the management of the forests, certain conditions must be fulfilled, such as :—

(1) The object to be realised must be of public importance.
(2) The advantages to be derived from the restrictions must be greater than the disadvantages caused thereby.
(3) The realisation of the object must be assured, without any other cheaper way being available.
(4) Compulsion should be resorted to only if private efforts are unable to realise the object aimed at.
(5) Owners who are subject to loss or curtailment of rights should be compensated.

The measures to be taken against threatening dangers differ much. In some cases it suffices to insist on the maintenance of existing forests, and to prevent their devastation ; in other cases the afforestation of bare lands may be necessary. The division of protection forests should be subject to State sanction. If the number of proprietors is large, the State should have authority to undertake the management of the forest. There should also be power of expropriation, if the desired object cannot be realised in any other way, but the final decision, whether expropriation is to be carried out, should rest with the law courts. The compensation to be given should at least be equal to the market value of the property ; in some cases a certain percentage over and above such value is indicated. The compensation may be paid in cash, or other land may be offered.

6. Forest Policy of the State.

Forestry is an industry based upon the productive power of the soil, which satisfies certain requirements of a country. This industry differs from others, and especially from agriculture, chiefly by the long time required for the maturing of the produce ; hence, continuity of action extending over a long period of time is an essential condition of successful forestry. A country requires a sustained annual supply of forest produce, for which, in the case of timber, a regular succession of age gradations, or age classes, is essential, whether they are mixed with each other or separated on different areas. In the latter case, especially, an area of some extent is required which is, in the majority of cases,

not in the possession of private persons ; hence, the State must step in and hold some of the land. In some cases, corporations are able to relieve the State in this respect. Under any circumstances, the State must lay down a distinct forest policy so as to secure adequate future requirements.

The first question for consideration is whether, and to what extent, the beneficial action of forests is required in the country, as indicated by its special conditions. As regards the *direct* effects, the following considerations are important :—

(1) The quantity of forest produce required in the country, or for export.

(2) The quantity and quality of substitutes for forest produce in the country.

(3) The position of the country, its communications with other countries rich in forests, the control which it exercises over them, and the safety of future supplies from them.

(4) The density of population and the area required for the production of food and other requirements.

(5) The price of land and labour, and the return which land yields under forest as compared with other modes of utilization.

(6) The area of waste and surplus land available for afforestation.

(7) The amount of capital available for investment.

A country so situated that the importation of forest produce is easy and cheap by sea or navigable rivers coming from countries rich in forests, and which is intersected by railways or other means of communication, or one which has control over other countries rich in forests, such as colonies, does not require forests to the same extent as those with reverse conditions. The same holds good as regards richness in coal, lignite, peat, or other substitutes for wood. In such cases, the area of forest can be reduced to that which suffices to make the country safe in case of an emergency. The financial aspect also affects the question ; where the interest derivable from forests is lower than that obtainable by using the land for other purposes, capitalists would not be inclined to invest in forestry. If the population of a country is very dense, all suitable land may be required for the production of food, which must always be the first consideration. If, on the

other hand, surplus or waste land is available, afforestation will provide additional work, and may give higher returns from the land than it did in the past.

As regards the *indirect* effects, the important points are the climate and the configuration of the country. A sea-bound country is, apart from wind breaks, less in want of forests than an inland country; a mountainous country is more in need of them than low-lying districts on account of their beneficial action as regards erosion, landslips, avalanches, the carrying away of soil, sudden floods, and the sustained feeding of springs.

All these matters must be considered in estimating the area and nature of forests required in a country. No general rule can be laid down in this respect; the question must be determined in accordance with the special conditions of each country. To show the differences actually existing in some European countries, the subjoined data are given :—

AREA OF FORESTS IN A NUMBER OF COUNTRIES.

Country.	Area of forest per head of population.	Percentage of total area under wood.	Percentage of forest belonging to the State or the Crown.
Sweden . .	9·41	47·6	33·2
Norway . .	7·53	21·0	28·5
Russia in Europe.	4·60	37·0	66·4
Hungary . .	1·40	35·0	16·0
Austria . .	1·10	33·0	7·0
German Empire .	0·62	25·9	33·7
France . .	0·62	16·2	12·0
Denmark . .	0·25	6·3	23·8
Belgium . .	0·20	17·7	4·8
Portugal . .	0·16	3·5	8·0
United Kingdom.	0·07	4·03	2·4
Europe, Average	1·95	31·03	

It will be observed that the area of forest per head of population varies from 9·41 acres to 0·07 acre, and the percentage of the total area of the country under forest from 47·6 to 3·5 per cent. Sweden, Norway and Russia, especially the latter, have as yet more forest than they require for their own consumption. Hungary and Austria were exporting countries before the war;

whether they will be so in future, and to what extent, is uncertain. All the other countries in the list import timber, headed by the United Kingdom and closely followed by Germany and Belgium. The extent of imports depends on the area of forest, the degree of industrial development of the country, and on its substitutes for wood.

After a full consideration of all these points, the State authority should draw up a definite forest policy in accordance with the special requirements of the country. The forest policy should be given the force of law by incorporating it in an Act or Ordinance. The details depend on local conditions, but special attention may be drawn to the following requirements :—

(1) Power should be provided to declare what areas shall be considered as forests and as such come under the provisions of the forest law.

(2) Power to provide for the establishment of State forests sufficient to safeguard the country in the case of an emergency, or to make good any deficiency in the supplies from corporation and private forests ; also to prohibit the disposal of State forests without the approval of Government.

(3) Power to determine the extent of rights in forests possessed by third persons, to regulate the exercise of such rights, or to commute them if their exercise should prevent a rational management of the forests.

(4) To prevent the establishment of new rights in areas declared as forests under the law.

(5) To manage the State forests for a sustained yield, and to authorise the State forest authority to take over the management of corporation and private forests, if necessary for the welfare of the country as a whole.

(6) To provide for the efficient protection of the forests and their produce against fire, theft or other damage by third persons, and for the punishment of offenders against the forest law.

(7) To provide for research in questions which have a bearing upon the best possible management and yield of forests and their protection against injurious agencies.

(8) To provide instruction in forestry and allied subjects, and

to organise a competent staff for carrying out the forest policy ; also to determine the powers and duties of the forest staff.

(9) Power to control corporation and private forests in so far as the welfare of the community demands, and especially as regards the establishment and management of Protection forests.

(10) Power to apply the provisions of the forest law to corporation and private forests, with the object of assisting their formation and development, wherever desirable.

PART II.

FORESTRY IN THE BRITISH EMPIRE.

A. GENERAL SUMMARY.

THE British Empire comprises approximately the following area and population :—

	Area, Square Miles.	Population Total, 1911.	Per Square Mile.
In Europe .	121,512	45,878,000	378
In Asia . .	2,068,850	323,359,000	156
In Africa . .	4,875,027	61,989,000	13
In America .	3,689,910	9,584,000	3
In Australasia .	3,190,660	6,198,000	2
Total .	13,945,959	447,008,000	32

It consists of the United Kingdom, India, the self-governing Dominions of Canada and Newfoundland, the Union of South Africa, the Commonwealth of Australia, the Dominion of New Zealand, and the following Crown Colonies and Protectorates : In Europe, 2 ; Asia, 10 ; Africa, 19 ; America, 11 ; and in Australasia, 3.

In this mighty Empire all sorts of conditions are met with. All shades of climate are represented, from eternal ice and snow to the highest tropical heat ; the rainfall ranges from absolute aridity to over 500 inches a year ; extensive low lands and plains alternate with mountainous regions rising to the greatest elevation on the face of the earth. Many parts of the Empire are densely populated, while others contain few inhabitants, or none at all. It is evidently impossible to deal with the forest question of such an Empire in a wholesale fashion ; that question must be studied and decided for each part of the Empire separately in the light of local conditions and requirements, but also with due consideration of the Empire as a whole. To do justice to the task a detailed knowledge of the conditions in all parts of the Empire is required.

Until lately such knowledge was available only for some parts, and very deficient as regards others. Much useful information has now been collected in connection with the Empire Forestry Conference held in 1920, and this has been fully utilized in the following pages.

1. Historical.

It is a curious fact that Great Britain, which was the last European nation to establish a forest department, had forest laws more than a thousand years ago. No doubt, the forest laws of William the Conqueror did not deal with the provision of forest produce. Their object was to secure and develop the King's chase; they were harsh and even cruel. Still, the fact remains that actual State, or Crown, forests existed. With the awakening of more rational ideas, these laws were gradually ameliorated and finally abolished. Remnants of the once extensive Crown forests now remain, such as the Forest of Dean, the New Forest, and some others, representing $2\frac{1}{2}$ per cent. of the forest area existing in these islands at the present time.

With the reduction of the old Crown forests and the ultimate abolishment of the cruel forest laws, private forests sprang up, probably in the first place for the purpose of amenities and the improvement of the shooting. The economic aspect, however, developed in the same degree as the forest area diminished, and already, in the seventeenth century, John Evelyn, in his "Sylva," wrote * "That we had better be without gold than without timber." As a result, the area of private forests in the United Kingdom amounts at the present time to about 3,000,000 acres. On the other hand, the State remained indifferent on the question of forestry. In the year 1855 an event occurred in India which had the greatest effect upon the development of forest conservancy, not only in the British Empire but also outside of it, and more particularly in the United States of America. Local attempts at forest conservancy had been made in India ever since the beginning of the nineteenth century, but with indifferent results. In the year 1855 Lord Dalhousie, Governor-General of India, took the matter in hand and appointed a qualified superintendent of the Pegu teak forests. That was the starting point of

* Quoted by Lord Lovat in his address at the Guildhall on the 7th July, 1920.

systematic forestry in India, and it developed into the establishment of the Indian Imperial Forest Department in the year 1864. The existing forests were explored, and those belonging to the State taken under the control of the Forest Department. A "Forest Act" was passed in 1865 but superseded in 1878 by a more comprehensive Act which greatly enlarged the functions and powers of the department. Working on the lines of that Act, the department proceeded to select suitable areas and to declare them permanent State forests; up to date, over 100,000 square miles of reserved State forests have been established. Working plans have been, or are being, prepared for them based on the principle of a sustained yield; the areas are protected against damage by fire and other sources of injury, and the regeneration of the forests forms a prominent part of the department's activity. As a result, the net revenue from the State forests is now more than ten times what it was in 1864.

The example thus set by India attracted the attention of other parts of the Empire, with the result that similar steps were taken, and, in many cases, the services of Indian forest officers were asked for. India has, as far as possible, met these requests; officers have been lent to Ceylon, the Federated Malay States, Mauritius, New Zealand, Australia, South-, West- and East-Africa, the Sudan, Cyprus, the West Indies and British Honduras. The development of forest conservancy in Canada has also been influenced by the example set by India. Last, but not least, the first scientifically trained forest officer employed in the British Crown forests was a distinguished Indian forest officer, and several Indian foresters have held, and are still holding, professorial chairs at British Universities.

The great indifference of the Government as regards forest conservancy in the United Kingdom commenced to be disturbed about the year 1883. Foresters, committees, commissions and associations urged the necessity of State interference, but it took 36 years and the great war to bring about the passing of the Forest Act of 1919, immediately followed by the establishment of the Forestry Commission as the forest authority of the United Kingdom. Almost the first work of that Commission was to organise an Imperial Forest Conference to which delegates from all parts of the Empire were invited. In sending out these invitations the

Commissioners asked for a statement describing the position of forestry in each part of the Empire, to be used as a basis upon which proposals for an Empire forest policy could be elaborated. Thirty-four such statements were received and printed, covering 517 foolscap pages. Some of these statements contain the required information, while others are deficient in various directions. Extracts showing the more important matters, with such critical remarks as appear called for, are recorded in subsequent pages. In this Summary attention may be drawn to a few points.

2. Area of the Forests.

Although the available data are not complete so as to deal with all parts of the Empire, those given below for the greater part of the area may be of general interest :—

	Area, square miles.	Per cent. of total area.
Forests, marketable . . .	685,130	8
,, unmarketable or inaccessible	1,112,030	12
,, unclassed . . .	40,000	—
Forests, total area. . . .	1,837,160	20
Agricultural land	1,570,030	17
Other land	5,753,030	63
Grand total of area dealt with .	9,160,220	100

The area given in the above statement represents about three acres per head of population, or $1\frac{1}{2}$ times that in Europe. Moreover, the $5\frac{3}{4}$ million square miles of " Other land " may be found, on further examination, to contain considerable additions to the now known forest area.

3. Ownership of the Forests.

Of the total forest area, 1,387,020 square miles are classed as State forests, equal to about 76 per cent. The rest belongs to corporations and private persons. The lowest percentage of State forests occurs in the United Kingdom with $2\frac{1}{2}$ per cent. In other parts of the Empire it is still high ; in South Africa, 37 per cent. ; in Australia, 69 per cent. ; in India, 75 per cent. ; in Canada, 93 per cent. ; and in British Guiana, 100 per cent. In

some parts, as in West Africa, the bulk of the forests belongs to native corporations.

The proportion of State forests dedicated to timber production varies much ; on an average it may be placed at 29 per cent.

4. Types of Forest.

The factors on which forest vegetation depends are temperature, moisture, light, and the physical and chemical condition of the soil. The first two of these agencies are greatly influenced by the configuration of the country, and especially by elevation and aspect. They differ so much in the several parts of the Empire that it is impossible to give here a summary of them.

The forests may be arranged into three great classes :— (1) Hardwood forests, (2) Conifer forests, and (3) Mixed forests. The first, really consisting of broad-leaved species, prevail in the tropical and semi-tropical parts, and they contain the most valuable species, such as Teak, Mahogany, Sandalwood, Ebony, Cedrela spp., Dipterocarps, especially Shorea, Eucalypts, and a very large number of other species. In temperate climates are found Oaks, Chestnuts, Maples, Beech, Birch, Elm, Alder and many others.

The greater part of the conifer forests is found in the temperate parts, but also in the sub-tropical and tropical parts. The more important species are Spruces, Pines, Larches, Firs (Silver and Douglas), Deodar, Podocarpus spp., Callitris spp., Juniperus spp., the New Zealand *Agathis australis*, the Queensland Araucarias and others.

The number of species of trees found in the Empire amounts to thousands ; indeed, it may be said that, with few exceptions, it contains all species. While there is no danger at present of the Empire running short of hardwoods, the case is different as regards coniferous timber. No doubt, conifers occupy more than one half of the Empire's forests, but the consumption of such timber amounts to something like 90 per cent. of the total requirements. The distribution of the conifer forests is very uneven, the greater part being situated in Canada, Newfoundland, India, East Africa, New Zealand, and a few parts of Australia. The result is that many parts of the Empire, while exporting hardwoods, are obliged to import coniferous timber. Naturally, the effort at

afforestation throughout the Empire is directed chiefly to the local production of conifers, wherever the climate is suitable for them.

5. Relationship of the State to Forestry.

Under this heading, legislation, administrative methods, assistance given to forestry and allied subjects are dealt with. It is a large subject and the progress made in the several parts of the Empire will be found in the notes given further on. Special attention is invited to India and the United Kingdom. In the former country the Forest Act of 1878, with its offshoots, still forms the basis of Indian forest policy, and it has been fully utilized in drawing up forest acts and ordinances in other parts of the Empire. The British Forestry Act of 1919 represents an excellent example of forest legislation. In both these cases the principle of working for a sustained yield in the future is laid down, this being the foundation of sound forest management. Good progress has also been made of late years in this direction in some of the Australian States.

6. The Forest Authority.

This varies very much. It consists of a Commission in the United Kingdom, in New South Wales, Victoria and South Australia; of a single Head in each of the Indian Provinces, Canada, Queensland, Western Australia, New Zealand, South Africa, and in the Crown Colonies generally. In several parts of the Empire the Head Officer is assisted by a consultative committee. A rudimentary authority, or none at all, exists in some of the colonies and protectorates. India has, in addition to the provincial authorities, an Inspector-General of Forests, who is the chief adviser to the Government of India.

As regards the general organisation, it has been recognised that a territorial agency is essential for an efficient conduct of the business. The details depend on local conditions. As an illustration it may be stated that in India the unit of executive charge is the Range, while a number of ranges form a Division, or controlling charge, and a number of the latter form a Circle, or administrative charge, presided over by a Conservator of Forests. In provinces which contain several Circles, a Chief Conservator

is appointed to act as an intermediary between the Conservators and the provincial Government. The recruitment of the superior staff is practically now restricted to men who have taken a degree or diploma at a recognised School of Forestry. The subordinate staff is generally recruited locally and trained in local forest schools.

7. Forest Education.

The first School of Forestry in the British Empire was started at Dehra Dun in India, in 1875, and actual theoretical instruction commenced in 1878. This school was originally destined for the education of Rangers and Foresters. A few years ago a course of instruction for the provincial part of the superior staff was added, while the education of the subordinate staff has been provincialised. In addition to Dehra Dun, there are now schools for the education of Rangers at Coimbatore in Madras, at Pyinmana in Burma, and at Dharwar in Bombay. There are also elementary schools for the education of Foresters and Guards in nearly all provinces.

On behalf of the Government of India, the first School of Forestry in Great Britain was organised in 1885 in connection with the Royal Indian Engineering College at Coopers Hill; it was transferred to the University of Oxford in 1905. A lectureship for forestry was established at Edinburgh University in 1889, and another at Bangor in 1904. Instruction in forestry has also been provided at Cambridge University, at the East of Scotland College of Agriculture, at Aberdeen, Glasgow, Durham College of Science, and at the Royal College of Science at Dublin. For the training of foresters and woodmen, schools exist in the Dean, at Chopwell Woods, Burley, Beaufort and at Avondale in Ireland.

Canada has schools of forestry at the Universities of Toronto, Laval, and in New Brunswick. Australia provides forestry instruction at the University of Adelaide; a school for the instruction of forest apprentices exists in Victoria, and another in New South Wales. A scheme for the establishment of a high class Commonwealth school of forestry in New South Wales is under consideration. A school for the instruction of subordinates exists at Tokai in South Africa.

8. Research and Experiments.

Research connected with forestry questions was commenced in India about 100 years ago. In the earlier days, botanical questions chiefly occupied the investigators. From about 1860 onwards, silvicultural questions were taken up, as well as the structure and properties of timbers and statistical matters. Part of these investigations were carried out by Government agency, but the greater part was the result of individual private exertions. During the period from 1860 to 1905 research and experiments produced a very large amount of new knowledge, as testified by the excellent publications issued during that time. Then, in 1906, the Dehra Dun Research Institute was organised, divided into the five sections of Silviculture, Economics, Botany, Zoology and Chemistry. The institute has fully justified its establishment, and a further extension on a grand scale is now under consideration. Research work is also done in the several provinces of India in connection with the institute at Dehra Dun.

A fair amount of research and experimental work has been done, in a somewhat disjointed way, by private persons, institutions and Government departments in Great Britain and Ireland. The Forestry Commission has been very active during the short time of its existence; it has already published preliminary Volume Tables for the Scots pine and the larch, as well as Yield tables for larch, Scots pine and spruce, with preliminary tables for Douglas fir, Corsican pine and Japanese larch. The Commission has also studied the insect conditions following the heavy war fellings, and problems connected with afforestation work generally. The fungoid diseases of the larch have been investigated and the results published. Fair progress has been made in the investigation of the mechanical properties of home-grown and colonial timbers.

In Canada, forest products have been dealt with at McGill. In Australia, systematic work has been commenced on the rate of growth of indigenous trees. Valuable experimental work has been done in South Africa in connection with afforestation. The trial of exotic species has been specially taken up in Great Britain and Ireland, in South Africa, Australia and New Zealand.

9. Increment and Utilization.

The balance between Increment and Utilization is of the first importance, because on it depends the possibility of a sustained

yield in the future. Unfortunately, the information supplied by the several parts of the Empire consists—a few cases excepted—of mere rough estimates, and in some cases not even of that. Picking out the countries for which an estimate has been given, the results are as follows :—

INCREMENT ON AREAS UNDER STATE CONTROL (EXCEPT THOSE IN THE UNITED KINGDOM).

	Area, square miles.	Increment in million cubic feet.			Per Acre.
		gross.	loss.	net.	cubic feet.
United Kingdom	5,180	41·6	4·2	37·4	14·3
British India .	126,310	1,212·5	35·5	1,177·0	14·7
British Columbia	149,340	796·5	302·3	494·2	5·2
Quebec . .	213,490	658·5	261·2	397·3	2·9
Queensland .	11,000	29·3	22·0	7·3	1·0
Victoria . .	9,380	180·0	30·6	149·4	24·8
Total . .	514,700	2,918·4	655·8	2,262·6	6·9

These data show that the average net increment on 514,700 square miles of forests amounts roughly to 7 cubic feet per acre a year. It is, however, impossible to say whether the same ratio applies to the rest of the forests. At the same time there is no doubt that under proper treatment the increment can be raised to several times the present amount.

The data given of the Utilization, although fairly accurate in some cases, are also unsatisfactory, because some of them are pre-war and others post-war figures; also in some cases only timber is given, while in others firewood is included. Such as they are, the data are as follows :—

United Kingdom .	80	million cubic feet.
British India . .	260	,, ,,
British Columbia .	150	,, ,,
Quebec . . .	240	,, ,,
Queensland . .	31	,, ,,
Victoria . . .	48	,, ,,
Total . .	809	,, ,,

The figures would indicate that the annual utilization amounts to only 36 per cent. of the increment.

10. Exports and Imports.

The several parts of the Empire can be arranged into two classes according to whether there is a net import or a net export. To the former belong the United Kingdom, British India, Australia, South Africa, Southern Rhodesia, the Malay States, British Guiana, and several of the smaller countries. To the net-exporting countries belong Canada, Newfoundland, the Gold Coast, Nigeria and British Honduras. The available data may be arranged as follows in million cubic feet :—

	Net Exports.	Net Imports.
United Kingdom	—	546·40
British India	—	2·70
Canada	360·60	—
Newfoundland	0·17	—
Australia	—	10·80
New Zealand	?	?
South Africa, the Union	—	19·50
Southern Rhodesia	—	0·23
Kenya Colony	0·17	—
Nigeria	0·87	—
Gold Coast	1·04	—
West Indies	—	1·30
British Honduras	0·57	—
British Guiana	—	0·22
Total	363·42	581·15

Net Imports : 217,730,000 cubic feet.

11. Income and Expenditure of the State Forests.

The results differ enormously according to the special conditions of each part of the Empire. There is a surplus of income over expenditure in some cases and a deficit in others. It has not been possible to prepare a general abstract for all parts of the Empire, but, as an example of the effects of systematic management on the principle of a sustained yield during the last 50 years, the case of India may be given. The Department was organised in 1864 and the following figures show the average annual results of periods of 5 years :—

	Income, Rs.	Expenditure, Rs.	Surplus, Rs.
Period 1864—1869 .	3,740,000	2,380,000	1,360,000
,, 1884—1889 .	11,670,000	7,430,000	4,240,000
,, 1904—1909 .	25,700,000	14,100,000	11,600,000
,, 1909—1914 .	29,600,000	16,370,000	13,230,000

During these 50 years the income has risen eight-fold and the surplus tenfold. Since the year 1914, the figures have been practically doubled, but that represents a rise which is chiefly due to the effect of the war, and it is impossible to say whether a reaction will come or not.

12. Summary.

An attempt has been made to draw the balance between Increment, Utilization, Exports and Imports from and into the Empire. Unfortunately the necessary data are not, in all cases, complete. All that can be said at the present time is that the annual net increment is about equal to double the annual consumption. Satisfactory as this appears at first sight, it is less so when the following qualifications are considered. In the first place, it would appear that in most cases the increment refers to all species, while the consumption refers to the better kinds of timber trees, the stock of which has in many cases undoubtedly decreased of late years. Moreover, firewood is included in some returns and only timber in others. On the other hand, in the majority of cases the data refer chiefly, if not altogether, to the forests which are at present accessible, while additional supplies can be made available by opening out the unmarketable and inaccessible forests. At the same time, the fact remains that between 4 and 5 million loads of timber have of late years been imported annually from foreign countries. This is partly due to the fact that the bulk of the Empire conifer forests are situated in Canada and Newfoundland. The imports into the Empire have steadily increased, certainly since 1884, so that they are now more than double what they were 38 years ago. If it is added that future supplies from foreign countries are anything but secure, it seems clear that efforts must be made to render the Empire independent of such imports. With this end in view, action must, without delay, be taken somewhat on the following lines :—

(1) Every part of the Empire must lay down a definite forest policy on the basis of a Forest Act or Ordinance.

(2) The establishment of an efficient forest staff fit to carry out that policy.

(3) The selection and demarcation of an area of State forests sufficient: *Either* to provide permanently the produce required by the country, with due consideration of the Empire as a whole; *Or*, at any rate, to make the country safe against an emergency, and encourage and assist corporations and private parties to produce the required balance of produce.

(4) Efficient protection of the forests especially against damage by fire, and the prevention of waste.

(5) Regeneration of the forests, especially of the valuable species, and the planting of an adequate proportion of conifers, wherever soft woods are deficient.

(6) Construction of suitable means of transport and the opening out of at present unmarketable or inaccessible forests according to requirements.

(7) The establishment of systematic research, so as to improve the methods of treatment, the quality of the produce and the development of local industries which rely on forest produce for their raw material.

(8) The introduction into the markets of species hitherto unknown, or considered inferior for use.

13. The British Empire Forestry Conference.

The conference, consisting of 43 delegates from practically all parts of the Empire, was opened on July 7th, 1920, by the Right Hon. The Lord Mayor of London at the Guildhall. It considered, with the above indicated information before it, the desirability of a rational forest policy of the Empire and, after six days' discussion, it passed the following resolutions, which have been brought by the delegates to the knowledge of their respective Governments:—

(1) *Forest Policy.*—In view of the great importance to the Empire as a whole, as well as to each of its component parts, of producing a sustained yield of all classes of timber, and of encouraging the most economical utilization of timber and other forest products, and of maintaining and improving climatic conditions in the interests of agriculture and water supply, each

of the Governments of the Empire should lay down a definite forest policy to be administered by a properly constituted and adequate forest service.

(2) *Survey of Resources.*—The foundation of a stable forest policy for the Empire and for its component parts must be the collection, co-ordination and dissemination of facts as to the existing state of the forests and the current and prospective demands on them.

(3) *Constitution and Status.*—In order to attain continuity in the development of forest resources it is desirable that certain elements of stability be secured in the constitution of the forest policy. This may be done by the following measures :—

(i.) The definition, where this has not been done already, of forest policy in a Forestry Act or Ordinance.

(ii.) The reservation for the purpose of economic management and development of forest land under conditions which prevent the alienation of any which is primarily suitable for forests except for reasons consistent with the maintenance of the forest policy as a whole.

(iii.) The assurance to the Forest Authority of funds sufficient to carry out the accepted policy for a series of years.

(iv.) The grant to members of the forestry service of the status of civil servants with due provision for pension.

(v.) The appointment as the chief officers of the forestry service of persons having a high standard of training in forestry, their selection and promotion being by merit alone.

(vi.) The establishment in each of the larger parts of the Empire and for the Colonies not possessing responsible government collectively, of an officer, or officers, having special duties of advising as to forest policy and surveying its execution.

(4) *Organisation of Forest Industries.*—It is extremely desirable that the Forest Authority should be in close touch and consultation with organisations representing the interests concerned in the extraction and utilization of timber and other forest products.

(5) *Publicity.*—It is the duty of the Forest Authority in every part of the Empire to adopt and encourage methods of education

and publicity in order that the people may be fully informed of the aims and purposes of forest policy and may thus be induced to co-operate towards its successful fulfilment.

(6) *Distribution of Forest Plants.*—The Conference have had brought to their attention the advantages which have accrued in several parts of the Empire from the wide distribution of forest plants, and desire to bring the method of encouraging tree-planting by distribution of plants either from Government or private nurseries gratuitously or at cost price to the earnest attention of their Governments.

(7) *Terminology and Trade Nomenclature.*—The following questions should be referred to the proposed Imperial Forestry Bureau immediately on its formation :—

(i.) Standardisation of forest terminology ;

(ii.) Correct identification of timbers, and standardisation of their trade names.

(8) *Research.*—The scheme of research work drawn up by a Committee receives the approval of the Conference, and is recommended to their Governments for early consideration and approval by them.

This takes the form of the report from a Committee appointed to prepare a draft scheme for the organisation of that research work which is essential to the progress of forestry, including both the production and utilization of forest produce, the Committee to pay particular regard to the importance of avoiding overlapping and of co-operation with existing institutions. The report deals with the organisation and sub-division of research, with the relation of the different parts of research to one another and to education and practice, and with the subjects of research both generally and in relation to the needs of the different parts of the Empire.

(9) *Education.*—It should be a primary duty of Forest Authorities throughout the Empire to establish systematic schemes of forestry education. It has been found for climatic and other reasons that it would not be possible for each part of the Empire to establish a complete scheme of forestry education of its own, and therefore it is essential that those parts of the Empire which are willing and able to establish complete systems should, as far as possible, frame such schemes with a view to combining

for meeting the needs of those parts which can only themselves make a partial provision for their requirements.

Part of this subject has been dealt with by a Committee whose report, which refers mainly to the higher training of forest officers, is approved by the Conference.

The main principles embodied in this report are as follows :—

(i.) That one institution for training forest officers be established in the United Kingdom.

(ii.) That students be selected from graduates having taken honours in pure or natural science at any recognised University.

(iii.) That it be an integral part of the work of the institution to arrange supplementary courses at suitable centres for students requiring special qualifications and also special courses for forest officers from any part of the Empire, whether at the institution itself or at centres of training in other parts of the world. The Governments should recognise these courses as part of the ordinary duties of the forest officers, at any time during their service, and the Governments concerned should give special facilities to forest officers in their service to attend such courses.

(iv.) That a Department of Research into the formation, tending and protection of forests be associated with the training institution.

(v.) Encouragement should be given to the existing provision made by Universities and Colleges for forestry instruction for those who do not desire to take the full course suggested for the forestry service. It appears that this is especially applicable to the United Kingdom.

It is also desirable to make adequate provision for woodmen's schools for the training of foresters as distinct from those which are intended for forest officers.

(10) *Forestry Bureau.* The Conference approve the suggestions and recommendations for the constitution of an Imperial Forestry Bureau which are contained in the report of a Committee and strongly urge upon their respective Governments that they should contribute to the support of the Bureau. They feel that it will be largely upon the work of such a Bureau that the proper development of the forestry resources of the Empire will

depend, and they therefore cannot over-emphasise its importance as a part of Empire organisation.

(11) *Future Conferences.*—The Conference is convinced that the holding of Conferences of Representatives of the Empire on forestry matters is of great service. They desire to thank the Forestry Commission of the United Kingdom for causing the Conference to be assembled and for making the necessary arrangements. They recommend that the next Conference be held in the year 1923 and that, if the Dominion Government approves, it be convened in Canada.

The discussions were throughout of a high standard, and it may be said that, with one exception, the resolutions were agreed to unanimously. The one exception referred to the question of the education of the superior staff. The majority of the Delegates were in favour of establishing a high-class central School of Forestry for the Empire away from any university, whereas a strong minority pressed its establishment in connection with a University. A compromise was arrived at by suggesting the appointment of a special committee to consider the question further. That Special Committee has since been appointed and reported in favour of attaching the new School to a university.

Apart from the subjects covered by the 11 resolutions, the Conference also discussed the desirability of establishing an Empire Forestry Association, and this has now been organised under influential patronage.

The Conference must be pronounced a complete success, and it is confidently expected that a sound forest policy will now be adopted in all parts of the British Empire.

The British Forestry Commission, by organising the Conference and guiding it to a successful end, deserves well of the Empire, quite apart from its remarkable activity in the introduction of a sound forest policy into Great Britain and Ireland on the basis of the Forestry Act of 1919.

B. FORESTRY IN GREAT BRITAIN AND IRELAND.

Great Britain and Ireland have an area of 121,309 square miles and a population of 45,500,000 people. It is situated between the 50th and 59th degrees of north latitude and 2 E. and 11 W. longitude. The conditions affecting forest growth in these islands

change so rapidly that it would lead too far to give a detailed account of them in this place, but a few notes will not be out of

SECTION I.—CONFIGURATION, SOIL AND CLIMATE

1. Geological Features.

The northern, western and south-western parts of Great Britain are mountainous or hilly and composed of hard primary or metamorphic rocks, while the centre and south of England are undulating in character and built up of soft secondary, tertiary and quaternary strata. In the latter areas are two belts of jurassic limestone running from the Cleveland Hills in Yorkshire to the Dorset coast, and more or less parallel with them run beds of chalk. The latter enclose three basins known as the London, the Weald and Hampshire basins. Considerable areas of sandy heath exist here, partly covered with pine woods in the Hampshire basin and in parts of the London basin : the Weald is heavy clay. The south-west of England consists chiefly of Devonian and carboniferous shales and grit with an area of granite on Dartmoor. The Midland plain in the centre of England is shut in on the west by the Welsh hills and broken up on the north by the Pennine Chain, which forms the backbone of England from Derbyshire to the Scottish border. The Pennines are composed of carboniferous rocks flanked on the west by the rugged Lake district. They rise to an elevation of 2,892 feet. The highest point in the Lake district rises to 3,210 feet.

The hill country in the south of Wales has the carboniferous series of the South Wales coal fields, which are succeeded to the north by old red sandstone ; further north are silurian, ordovician and cambrian rocks culminating in Snowdon with an elevation of 3,560 feet above the sea.

In Scotland, the border district and the country to the north of it are known as the Southern Uplands, the rocks being mainly silurian and ordovician shales and grits with igneous rocks, the mountains rising to more than 2,000 feet. The central lowlands stretch from the Firth of Forth on the east to the Firth of Clyde on the west, and include rocks of carboniferous age and igneous rocks of various ages. They are succeeded on the north by a broad band of old red sandstone.

Practically the whole of the remainder of Scotland consists of a complex series of igneous and metamorphic rocks, which form the wild mountain scenery of the Highlands. In it are many mountains over 3,000 feet elevation, culminating with Ben Nevis, 4,406 feet elevation, the highest mountain in the British islands. The western coastline is broken by numerous inlets from the sea. The watershed lies close to the western coast, and the rivers flow towards the lower ground bordering the North Sea. The heavy glaciation of the past has produced numerous lochs, as it has done in the Lake district and in North Wales.

In Ireland, a central limestone plain occupies about half the country marked by the presence of glacial deposits and peat. It is surrounded by hills. The Wicklow mountains consist of silurian, granitic and metamorphic rocks, and they rise to 3,000 feet. In the southern counties old red sandstone mountains rise to about 2,500 feet; the south-west country is rugged and broken and composed chiefly of old red sandstone, mountain limestone and millstone grit. In the Killarney district elevations of 3,400 feet are reached.

2. Soils.

Owing to the diversified surface of the country it is very difficult to give even a general account of the soils. In some parts they bear a fairly direct relation to the underlying strata, but in other districts, and especially in the lowlands, that relationship is frequently obscured by glacial drifts. In the mountainous districts glacial deposits generally take the form of moraines or of deposits of clay usually associated with peat. The question of peat generally is of great importance; it is of varying character and covers large areas. Only in rare cases can such areas be reclaimed for agriculture, but they are of special importance as regards further afforestation of the country.

3. Climate.

The prevalence of the west and south-west winds and the incidence of the warm waters of the Gulf Stream on the western shores of the islands render the climate equable and moist. There are no extremes of cold in winter and of heat in summer. The mean temperature of January ranges from 38 degrees in the east to 44 in

the south-west with the isotherm of 40 running almost north and south through the centre of the islands. The mean temperature of July ranges from 55 degrees in the north of Scotland to 67 in the south-east of England, while the isotherm of 60 passes from west to east through the centre of Ireland and England. The mean annual temperature varies from 47 in the north to 51 in the south. Winter temperatures below 10 degrees and summer temperatures above 90 degrees are uncommon.

The rainfall is heaviest in the western mountainous districts, showing an average of 50 to 60 inches, with a maximum of 200 inches on Snowdon. It decreases gradually to 25 inches on the east coast of England and Scotland, and to about 30 inches on the east coast of Ireland. The rainfall is fairly distributed over the four seasons of the year, though spring is the driest and autumn the wettest season; drought of sufficient intensity to kill other than newly planted trees is of rare occurrence.

The relative humidity of the atmosphere is almost always high; fogs and a cloudy sky are of frequent occurrence. Snow falls in most winters, but, except in the mountains, rarely lies for more than a few days.

There is a difference between the climate of the east and that of the west, the former being colder and drier than the latter. Certain species coming from a more southern climate do well only in the south-west of England and Ireland; also, firs and spruces attain a better development in the west, and pines in the east, but otherwise the differences are not sufficient to inhibit in the one region the growth of any tree species which flourishes in the other.

SECTION II.—THE FORESTS AND THEIR PRODUCE.

1. The Main Types of Forest Growth.

During the great Ice Age all tree vegetation, with the exception of some arctic forms, was swept away. When the ice receded the trees of historic times came in, and of these the following are considered indigenous:—Scots pine, the common juniper, yew, oak, ash, beech, alder, hazel, birch, cherry, hornbeam, wych elm, holly, field maple, white beam, white willow, black poplar, aspen, and mountain ash, or rowan.

It has been held that the glacial epoch in Central Europe was

followed, in order, by tundra, steppe and, finally, by forest, the latter continuing to the present time, but the three periods do not seem to be strongly marked in the British Isles. At the height of the forest period probably the greater part of the country was covered with forest, except the highest mountains. Remnants of oak and Scots pine have been found up to an elevation of 2,500 feet above sea level. The indigenous forests have been classified as follows :—

(1) On alluvial deposits : Willow, alder, ash and poplar, chiefly along rivers.

(2) On dry sandy soils : Oak, beech, birch, Scots pine ; on sandy heaths of Surrey, Hants and Dorset.

(3) On soils over old silicious rocks : Oak and birch ; in the hilly districts of western and northern England, Wales and southern Scotland, they were of great extent.

(4) Indigenous pine forests : In many parts of the British Isles particularly in the eastern highlands of Scotland.

(5) Beech woods : On the chalk downs of South England, also on the carboniferous limestones ; associated with the beech was the yew.

(6) Ash woods : On fissured limestone, in Somerset, Derbyshire and in Ireland.

(7) Oak forests : On the clay soils of lowlands.

(8) Oak-ash forests : In lowland districts on marl soils.

Great changes have occurred in these forests, due partly to nature and partly to the action of man. The forests on alluvial soil have made room for agriculture. The ash, beech and birch forests have degenerated or been planted with conifers. The oak forests on old silicious rocks have, to a great extent, disappeared by changing into grassy or bracken-covered hills ; parts have been destroyed or felled for fuel, timber, and charcoal making ; parts have been maintained as coppice ; other parts were replanted with conifers, such as larch, Scots pine, spruce and lately with exotic species : other parts remain in the hilly district ; the soil of all these parts is fit for the growth of first-class coniferous timber. The indigenous pine forests are gradually being cut. Of the beech forests considerable remnants are found in the Chiltern Hills. Of the ash woods and oak-ash woods small fragments remain, the rest having been converted into pasture lands. The oak

forests on clay have mostly disappeared, the largest remnants being found in Northampton and the weald of Sussex.

The present distribution may be described as follows:—The broad-leaved, mixed broad-leaved and conifers, and coppice woods of England occur chiefly in the southern and western districts. Sussex, Kent and Surrey are the best wooded districts, containing 20 per cent. of the total woodlands of England and Wales, most of them being coppice or coppice with standards. The Scots pine dominates on the sandy soils of Surrey and Hampshire. Larch is widely distributed but commonest in the hills of England and Wales. In Scotland two-thirds of the woods are situated in the north-eastern and highland districts. Along the east coast, the valley of the Dee and Strathspey, Scots pine predominates. On the west coast larch is the most common conifer. Stretches of poor oak and birch are still found on the whole west coast of Great Britain. In Ireland the south alone is well wooded, the indigenous forest having there been replanted with conifers, especially with larch.

2. Area of Existing Forests.

There is little exact evidence showing the progressive deforestation of Britain with the increase of population. In the earliest accounts the country is described as covered with forest. In the reign of William the Conqueror the woods were still very numerous and extensive, and in the time of Edward IV. England is described as an overgrown country. It is stated that the first attack of any consequence upon the forest was made during the reign of Henry VIII., followed by a continued increase of consumption of oak timber in consequence of the gradual extension of commerce, the increasing requirements of the Royal Navy, and of house construction during the sixteenth and seventeenth centuries, apart from the extension of agriculture. The progress of depletion was considerably hastened during the civil wars.

An attempt at planting was made in the early part of the eighteenth century, but it does not appear that the area under wood was materially increased. During the latter half of that century the timber outlook became serious, and the State then evinced an active interest in the matter. It was found that the Crown forests were providing only a fraction of the timber

annually required for the Navy. Arrangements were made for planting 100,000 acres, and by 1823 over 50,000 acres had actually been planted, chiefly on Crown lands. Later on it was found that oak was no longer required for the Navy, but the Crown forests were maintained, and, during the last 20 years, even slightly increased. On the whole, however, there has been a slow but steady decrease in the area under wood. In Scotland large plantations of conifers were made between 1780 and 1830, especially of larch, many of which were felled in the latter part of the nineteenth century and not replanted. Until a quite recent date the wooded area of Ireland has steadily decreased.

The subjoined table shows the distribution of the land and the areas of forest in square miles at the outbreak of the war :—

Country.	Agricultural Land.	Forest.	Other Land.	Total Land Area.
England and Wales	48,340	2,940	6,750	58,030
Scotland . .	21,770	1,780	6,250	29,800
Ireland . .	26,970	460	4,210	31,640
United Kingdom .	97,080	5,180	17,210	119,470
Percentage . .	81·3	4·3	14·4	100

During the war 470 square miles were cleared, but endeavours will be made to restock the cleared areas.

3. Ownership of the Forests.

The details of ownership of the forests are shown below, the areas being given in square miles :—

Country.	The State.	Corporations.	Private Owners.	Total.
England . .	102	54	2,784	2,940
Scotland . .	2	1	1,777	1,780
Ireland . .	30	—	430	460
United Kingdom .	134	55	4,991	5,180
Percentage . .	2·6	1·1	96·3	100

The State forests are really Crown forests, but each Sovereign, on accession, hands them over to the State together with other Crown estates in return for the grant of the Civil List.

4. Annual Increment of the Forests.

The data available for estimating the actual increment of home-grown timber are very limited, and the following figures must be accepted with reserve. More accurate data on the production of timber have lately been published by the Forestry Commission in Bulletin No. 3, but they refer to well-stocked coniferous woods and make no allowance for understocking.

The estimated average annual increment during the years 1909—1913, after allowing 10 per cent. for loss by fire, decay, waste, &c., amounts to 47 million cubic feet. It is estimated that, owing to the felling of about 750 million cubic feet on 470 square miles during the war, the increment in the immediate future is not likely to exceed 37 million feet annually, unless the cleared areas are replanted without delay.

5. Imports and Exports of Timber.

The import of timber into the United Kingdom began to grow during the second half of the eighteenth century; reliable data are available only from the year 1843 onwards. They show the following average annual imports of unmanufactured timber :—

Periods.	Loads.	Value, £.	Value, £ per Load.
1843—1852	1,867,000	?	?
1853—1862	2,720,000	9,058,000	3·34
1863—1872	4,155,000	12,154,000	2·93
1873—1882	5,880,000	16,438,000	2·80
1883—1892	6,624,000	15,146,000	2·29
1893—1902	8,795,000	20,527,000	2·36
1903—1912	9,596,000	23,675,000	2·47
1913 only	11,590,000	33,789,000	2·92

The above statement shows that the average increase per decade amounts to 1,288,000 loads, with a maximum of 2,171,000 loads during the decade 1893—1902. Another maximum seemed to have commenced in 1913, when the outbreak of the war altered the usual conditions. Of the imported timber 90 per cent. was coniferous wood and 10 per cent. so-called hard woods.

The figures also show that the price per load fell from 1853 to 1892. About the latter year it had reached a minimum; since that time the price has risen slowly but steadily, so that the increase between 1892 and 1913 represents 28 per cent. On

examining the data in more detail the actual increase was found to represent not less than 30 per cent.

There was a small export of timber before the war. The following figures show the average annual exports and net imports during the years 1909—1913 :—

Imports.	10,203,000 loads,	valued at	£27,560,000
Exports.	121,000 ,,	,,	£1,015,000
Net Imports	10,082,000 ,,	,,	£26,545,000

It may be added that immediately before the war the average annual consumption of timber per head of population came to 14 cubic feet.

6. The Sources of Imported Timber.

Sources of Supply of Unmanufactured Timber. Annual Average of the Years 1909—1913.

(Quantities in thousands of loads, value in thousands of £.)

Source of Supply.	Conifers.		Hard Woods.		Totals.	
	Loads.	£	Loads.	£	Loads.	£
British Possessions.						
Canada	1,035	3,374	20	142	1,055	3,516
Newfoundland	3	8	—	—	3	8
British Honduras	—	—	12	106	12	106
British West Africa	—	—	35	296	35	296
British India	—	—	36	610	36	610
Australia	—	—	39	166	39	166
New Zealand	4	33	—	—	4	33
Other British Possessions	1	6	11	90	12	96
Total British Possessions.	1,043	3,421	153	1,410	1,196	4,831
Foreign Countries.						
Russia	4,566	10,558	26	244	4,592	10,802
Sweden	1,579	3,775	—	—	1,579	3,775
Norway	495	1,394	—	—	495	1,394
France	837	743	—	—	837	743
Portugal	311	264	—	—	311	264
Spain	81	69	—	—	81	69
Germany	183	619	18	123	201	742
Austria-Hungary	—	—	6	100	6	100
United States of America	527	2,322	261	1,637	788	3,959
Cuba	—	—	12	83	12	83
Mexico	—	—	4	32	4	32
French West Africa	—	—	30	232	30	232
Siam	—	—	10	165	10	165
Java	—	—	4	53	4	53
Other Foreign Countries	30	106	27	210	57	316
Total Foreign Countries	8,609	19,850	398	2,879	9,007	22,729
Grand Total	9,652	23,271	551	4,289	10,203	27,560

It is of special interest to know whence the imported timber came. The appended statement exhibits the average amount of unmanufactured timber imported annually during the years 1909—1913. From that statement and a similar one for the year 1899 prepared by the author and published in the *Journal of the Society of Arts*, of March 1st, 1901, the following conclusions can be drawn :—

(1) Of the imports, 12 per cent. came from British possessions and 88 per cent. from foreign countries, the corresponding figures for 1899 being 22 and 78 per cent.

(2) Coniferous timber imported during the years 1909—1913 occupied 95 per cent., and hardwoods 5 per cent.

(3) The three main centres of supply are Northern Europe, South-western Europe, and North America.

Russia, Sweden and Norway are the most important countries in Northern Europe ; they sent 6,666,000 loads, of which 6,640,000 were coniferous timber, including about 2 million loads of pitwood. There has, however, been an important change since the year 1899, which the following figures will illustrate :—

Year.	From Russia.	From Sweden.	From Norway.	Total, Loads.
1899 . .	2,241,928	2,305,599	836,127	5,383,654
1909—1913 .	4,592,000	1,579,000	495,000	6,666,000
Increase .	2,350,072	—	—	1,282,346
Decrease .	—	726,599	341,127	—

The imports from Norway and Sweden have fallen off by more than a million loads, while those from Russia have been more than doubled, thus covering not only the decrease from Sweden and Norway, but also that from Canada.

France, Portugal and Spain have sent 1,229,000 loads of pitwood, which came mainly from maritime pine forests ; they were absorbed by the South Wales coalfields.

The United States of America sent 788,000 loads, of which 527,000 were conifers and the rest various kinds of hardwoods. The imports from Canada amounted to 1,055,000 loads, of which 1,035,000 were conifers and the balance hardwoods. Some years ago the greater part of the timber exported by Canada came to the United Kingdom and the rest went chiefly to the United

States, but now the position has been reversed, and it seems likely that this change will be further intensified as time goes on, owing to the ever increasing requirements of the United States.

The above-mentioned three main sources of supply provided 9,738,000 loads, including practically all the coniferous timber. The balance of 465,000 loads include teak from Burma, Siam and Java, mahogany from the Gold Coast, Honduras, French West Africa, Cuba, Mexico, and other places. Other furniture woods came from the United States, Australia, Canada, South Russia and a variety of other countries. Austria sent a small quantity of oak and walnut; the imports from Germany were mostly trans-shipments.

As regards future supplies it may be said that those of hard woods generally are not endangered, as there are great stocks available in many parts of the earth, some of which have not yet been touched. The supply of coniferous timber depends chiefly on Russia and Canada. Both have areas of coniferous forests so extensive that either of them could supply all other nations for ever, if the forests were managed on the principle of a sustained yield. It is impossible to say at this moment what the fate of the Russian forests may be; hence, the United Kingdom takes a special interest in the management of the Canadian forests. On it depend the measures to be taken in Britain to secure an adequate supply of coniferous woods in the future.

7. Imports of Other Forest Produce.

Of these the following may be mentioned :—

Imports and Exports of Wood Manufactures and Other Forest Products.

(Annual average of the years 1909—1913.)

Type of Produce.	Imports, £.	Exports, £.	Net Imports, £
Wood Manufactures . .	2,695,000	2,212,000	483,000
Pulp of Wood . . .	4,058,000	123,000	3,935,000
Minor Products . . .	3,814,000	1,332,000	2,482,000
Materials Manufactured by Chemical Processes . .	2,257,000	128,000	2,129,000
Total	12,824,000	3,795,000	9,029,000
Add Rubber partly Natural and partly Planted, about			14,000,000 in 1913
Add Vegetable Oils, partly Natural and partly Planted, about			5,000,000 only.
		Total . . .	28,029,000

The following notes indicate the principal sources of the various articles :—

Wood Manufactures : United States, 40 per cent. ; Russia, 18 per cent. ; Germany, 13 per cent. ; Sweden, 7·5 per cent. ; France, 6·5 per cent.

Pulp Wood : Norway, £1,218,000 ; Sweden, £1,967,000 ; Canada, £155,000 ; Russia, £315,000 ; Germany, £266,000 ; Newfoundland, £66,000.

Minor Produce : Cork, £1,075,000, from Portugal, Spain and France ; gutta-percha, £914,000, from Germany, Dutch Guiana, Venezuela ; myrobolans, £171,000, from India ; kauri gum, £627,000, from New Zealand ; logwood, £40,000, from British West Indies and Mexico ; lac dye gum, £443,000, from British India.; tanning substances, £253,000, from Natal and Belgium ; valonia, £165,000, from Turkey ; cutch, £91,000, from British India, Straits Settlements and British Borneo.

Materials manufactured by Chemical Processes : Resin, £1,003,200 ; turpentine oil, £882,000, from United States Russia, France ; acetate of lime, £41,000, from United States and Canada ; acetone, £107,000, from United States, Germany and Austria-Hungary ; acetic acid, £84,000, from Netherlands, Belgium, Norway, Germany and United States ; tar (other than coal tar), £83,000 from Russia, Sweden, Germany, United States ; methyl alcohol, £56,000, from United States, Germany, Canada, and other foreign States.

8. Forest Industries.

The available data showing the extent to which industries are dependent on forest produce are not complete enough to make it worth while giving them here. That dependency is much greater than is frequently supposed. In order to show this the following data, taken from the Census of Population of 1911, of the number of persons employed in connection with forests and their products are given in the table on p. 72 :—

	Number of Persons Employed.			
	In England and Wales.	Scotland.	Ireland.	Total.
Woodmen, Nursery and Seedsmen	42,209	5,515	697	48,421
On Ships and Boats . . .	31,775	10,224	7,687	49,686
On Vehicles	101,208	9,560	3,405	114,173
Musical Instruments . . .	16,754	802	246	17,802
Tackle for Sports and Games .	11,152	1,540	104	12,796
Buildings and Construction .	214,422	29,771	24,824	269,017
Wood, Furniture, Fittings, etc. .	114,613	12,672	5,079	132,364
Wood and Bark . . .	113,052	21,124	5,350	139,526
Total	645,185	91,208	47,392	783,785

The forester is specially interested in the proper utilization of small wood, which is not fit for timber, or used as fuel. Such wood can be utilized (*a*) In dry distillation leading to the manufacture of charcoal, acetone, methyl alcohol and other bye-products. (*b*) Small wood, such as is derived from coppice of ash, oak, beech and birch, which is not fit for pit-wood, is used for chair legs, tool handles, bobbins, barrel hoops, toy-making, hurdles, turnery generally. Industries of this class have been established in the Chiltern hills, Tintern woods and elsewhere.

9. Activities of Private Individuals and Corporations.

It has been shown above that 96·3 per cent. of the existing forests are private property. As a matter of fact, the amount of enterprise in forestry shown by private proprietors has been an outstanding feature in the past. They had to work out the best and most remunerative methods of treatment of the indigenous species as well as to experiment with exotic species, such as Douglas fir and Sitka spruce, which promised to be more remunerative than the former. In nearly every case the incentive to progress came from individuals and not from the State or corporations. Only in recent years has a change come, when the State has taken up the subject of forestry, and when Corporations set about to secure the catchment areas of rivers for their water supply. Some of the latter have adopted schemes of afforestation of parts of the catchment areas, and up to date about 10 square miles have actually been planted.

The catchment areas have been estimated to contain some

1,450 square miles in which the water rights are held by 250 local authorities and 14 private companies. The catchment areas are for the most part situated on high ground; they contain a good deal of unplantable land, but also a fair proportion of land fit for afforestation, which, it is hoped, will be put under forest during the next 20 years. The Corporations of Liverpool, Manchester, Leeds and Birmingham have taken the lead in these planting schemes.

Some of the university colleges and semi-State departments are also holders of woodlands, such as :—

The Ecclesiastical Commissioners	.	17	square miles.
The Duchy of Lancaster	.	3	,, ,,
The Duchy of Cornwall	.	2·5	,, ,,
Oxford Colleges	.	9	,, ,,
Cambridge Colleges	.	2·5	,, ,,
Total	.	34	,, ,,

The Duchy of Cornwall has recently begun planting at the rate of 250 acres a year on Dartmoor, and intends to work up to 8 square miles in the locality.

The City of London is the holder of Epping Forest covering some ten square miles. It was made over to the City by the State, and it serves as an amenity wood, more especially for the East End of London.

10. Societies Interested in Forestry.

Forestry in the United Kingdom has undoubtedly been materially advanced by various societies interested in the subject. They have kept the importance of forestry before the public, stimulated private endeavour, urged upon Government action on the part of the State and supported forest development generally. The following are the more important of these societies :—

(1) The Royal Scottish Arboricultural Society, founded in 1854, and comprising now 1,750 members. The society publishes *Transactions* half-yearly.

(2) The Royal English Arboricultural Society, founded in 1882, with 1,450 members at the present time. It publishes the *Quarterly Journal of Forestry*.

(3) The Irish Forestry Society.
(4) The English Forestry Association, which deals principally with the organisation of the market for British timber, and the distribution of information on forestry generally.
(5) The Landowners' Co-operative Forestry Society of Scotland, performing commercial functions in connection with forestry.

The following societies are also interested in forestry :—The Surveyors' Institution, the Land Agents' Society, the Royal Agricultural Society of England, the Highland and Agricultural Society, and several others.

11. Education and Research.

Systematic forestry education was commenced in 1885, when the first School of Forestry in the United Kingdom was organised, on behalf of the Government of India, by the author of this book in connection with the Royal Indian Engineering College, Coopers Hill. On the closing of that College, the School was transferred, in 1905, to the University of Oxford. Instruction in forestry was, by degrees, organised at other universities and colleges so that at the present time such instruction is obtainable at the following institutions :—

Oxford University ; Cambridge University ; University of Wales, Bangor ; the Armstrong College, University of Durham ; Edinburgh University ; Aberdeen University ; Edinburgh and East of Scotland College of Agriculture ; Royal College of Science, Dublin.

The Oxford School of Forestry is the best known of these establishments, where the great majority of the Indian forest probationers have been educated, first at Coopers Hill and, since 1905, at Oxford, as well as a considerable number of other forestry students, who have found professional occupation in practically all parts of the British Empire. The course of study comprises now the following subjects :—

(1) The elements of Physics, Chemistry, and Biology.
(2) The formation and properties of Soils, including the elements of Geology.
(3) Systematic Botany with special reference to trees, shrubs and other plants of interest in forestry.

(4) Forestry in all its branches.

(5) Forest Engineering and Surveying.

(6) A practical course extending over not less than six months.

The elements of Biology comprise a botanical and a zoological part; the former includes a course on the structure and function of the stem, leaf, root, flower, fruit and seed of plants; the zoological part deals specially with the animals which are of interest to the forester and with the classification of insects.

Forestry is divided into (*a*) the Economics of Forestry and Forest Policy; (*b*) Silviculture; (*c*) Forest Protection, including special courses on forest insects and on fungi; (*d*) Forest Utilization, with a special course on the structure and quality of timber; (*e*) Forest Mensuration; (*f*) Forest Management; (*g*) Forest Valuation and Finance.

Practical work in the woods accompanies the theoretical instruction during term time in Bagley Wood, situated within two miles of the University, where broad-leaved woods and extensive plantations of conifers are studied, including a series of experimental plots used for statistical purposes, and a forest nursery.

The Practical Course is taken during the vacations, partly in the Dean, High Meadow Woods, and the Tintern Crown woods, and partly by visits to other British and continental forests.

Students who have satisfied the examiners in the above subjects, which they can do in the course of two years, receive the Diploma in Forestry. Those who have passed Responsions and remain a third year are also awarded the B.A. degree. Special courses are arranged, as required, in British Estate Forestry and in subjects wanted by Probationers for the Indian Forest Service.

A Research Institute is attached to the School of Forestry, which has, up to date, dealt with the diseases of trees, especially of the larch, soil surveys and entomological questions. The comparative rate of growth of important forest trees is studied in sample plots established on silvicultural lines in Bagley Wood.

The University of Cambridge instituted instruction in forestry in 1907 by appointing a Reader in Forestry. A Diploma in Forestry is offered to those who satisfy the examiners in forestry and the allied sciences in a course extending over two years.

The degree of B.A. in a group of subjects including forestry, is open to candidates who keep three years' residence at Cambridge. Facilities for practical work are provided on the Midhurst Estate in Sussex. Investigations are carried on regarding timber technology, identification of colonial timbers, and the properties of timber in respect of dye-stuffs.

The University of Wales, Bangor, in addition to the B.Sc. degree after three years study, provides a two years' diploma course designed to meet the requirements of students who cannot afford the time necessary for obtaining the higher qualifications of a degree. Before obtaining the diploma at least six months must be spent in practical training in forestry. An experimental area of 50 acres in extent has been laid out, and investigations regarding the rate of growth of the principal trees have been conducted on a number of private estates. Research regarding the influence of heredity from seeds and damage done to trees by smoke and chemical fumes were interrupted by the war.

The Armstrong College, University of Durham, offers no degree in forestry, but agricultural students may take forestry as a subsidiary subject for the degree examination and the College Diploma in Agriculture. There is also a special course in forestry including practical work and demonstration in the Chopwell woods. These woods, extending over 900 acres, are now systematically managed. Experimental plantations at Cockle Park are also available for demonstration. Before the war research on the preservative treatment of timber was conducted.

Edinburgh University gives a three years' course for the B.Sc. degree in forestry, the syllabus being similar, in general character, to that followed at Oxford University; practical courses are conducted in woods in Scotland and at the forest of Dean. Visits to the Continent, as usual before the war, have been resumed. A two years' diploma course, open only to officers and others who have served in H.M. Forces during the war, is also provided.

Aberdeen University provides a degree course of three years duration, a diploma course of two years, and an applied science course which may extend over a single session only. A forest garden at Craibstone affords scope for training the students in practical work for experiments and demonstration. There are

also extensive forest areas in the neighbourhood of Aberdeen. Research work is being pursued on the germination of beech seed and the subsequent growth of the seedlings; also into the classification of forest soils according to geological characters and the determination of the most suitable species for afforestation.

The Edinburgh and East of Scotland College of Agriculture holds at present only evening classes under the College scheme of extension work.

The Royal College of Science for Ireland, Dublin, awards a Diploma in Forestry to successful students, the course of instruction extending over four years. Research has been carried out on the hybridisation of various species of trees, particularly poplars; also on the distinguishing features of the Oregon and Colorado Douglas firs.

Schools for Forest Apprentices, intended for working men only, are conducted departmentally by the Forestry Commissioners. The courses extend over two years, and the number of apprentices at each school is limited to about 24. The men are chosen on their merits. The first school was established at the Forest of Dean in 1904 and has worked satisfactorily. In future the apprentices will receive a fixed allowance and will be lodged and catered for free of charge in hostels attached to the school. Class-room instruction is limited to 1½ days per week, the remainder of the time being spent working in the woods under trained foremen, and performing the ordinary work of a forester. Schools for forest apprentices have now been established at: Parkend in the Forest of Dean; Burley, in the New Forest; Chopwell, Rowlands Gill, near Newcastle; Beaufort, Beauly, Inverness-shire; Avondale, Rathdrum, Co. Wicklow. The establishment of further schools is under consideration. Courses of a few weeks for landowners are also held annually.

The Research Department of the Imperial College of Science and Technology, London, has, during the last 12 years, conducted investigations on the mechanical values of timber from home-grown and foreign woods; timber used in aircraft; Scots pine for use in paving blocks; the relation of timber to various adhesives; structure of wood for purposes of identification and in relation to shrinking, warping, &c.; the loss of water from wood with reference to kiln-drying; improvement of the proper-

ties of timber such as water-proofing, fire-proofing and the preservative treatment of wood.

Research and Experimental Work under the Forest Authority: Before that Authority was established, over 30 permanent sample plots were established in 1913—1915 in woods of larch, Scots pine and other species, seventeen of which have already been re-measured. The selection of additional plots is proceeding in England and Scotland. Comparative plots are selected, where possible, and different grades of thinning applied to study the influence of treatment upon the increment of woods. During the years 1917—1920, a statistical survey has been carried out, in the course of which over 1,100 sample plots were measured in coniferous woods throughout the British Isles, mostly in woods felled during the war. From the data thus obtained have been constructed: (*a*) Volume Tables for Larch and Scots Pine, and (*b*) Yield Tables for European Larch, Scots Pine and Norway Spruce, also preliminary tables for Oregon Douglas Fir, Corsican Pine and Japanese Larch. These yield tables are incorporated in Bulletin No. 3, published by the Forestry Commissioners.

Investigations on forest insects are being carried out by the Commissioners' Entomologist. The results so far obtained have been published in Bulletin No. 2. Experiments on the control of the pine weevil, *Hylobius abietis*, are being continued; also, progress has been made in investigating the biology of the Douglas fir seed fly, *Megastigmus spermotrophus*. The aphis, *Chermes cooleyi*, attacking the Douglas fir, is receiving attention.

12. The Importance of Forestry to the Nation.

The æsthetic effects of forests have caused the establishment in the British Islands of fine parks and artistically placed woodlands, which render the country so beautiful and attractive. By developing a taste for the charms of landscape, forests exercise a beneficial influence upon the moral and physical development of the people, and contribute towards the peace and contentment of the human mind. The effect is by no means confined to the rural population; it is of equal, if not greater, importance to the dweller in the towns, and especially to the working classes. Woodlands in the vicinity of the towns should, if possible, be established to which the people can go on free days to enjoy pure

and fresh air. This will have a most beneficial effect upon them during the week's labour, as well as upon their children. Corporations and County Councils should take the matter in hand, and the Forestry Commissioners will, doubtlessly, not lose sight of it.

The effects of forests upon the rainfall of these islands is small, if it exists at all; besides, there is quite enough rain, and in many places, too much. On the other hand, forests have a decidedly beneficial effect upon the preservation of moisture, especially during spells of dry weather, as they greatly reduce evaporation.

The mechanical effect of forests on the stability of the soil on sloping ground is considerable. Up to the present time, water rushing down bare hillsides has not done irretrievable damage in these islands, but the beginning of such action can be seen in the northern counties of England, or on the route from Chester to Holyhead, where the water has cut into the hillsides and produced indentations which will certainly increase, if nothing is done to arrest the action. Unless the mischief is stopped in time it may afterwards necessitate the construction of costly works, such as embankments, dams and weirs. In all these cases afforestation acts beneficially.

There are signs in various parts of the country that peat bogs are increasing owing to the unprotected state of waste lands, such as are found, for instance, in the New Forest. Indeed, some observers are of opinion that the peat bogs in Ireland came into existence since the original forests were destroyed.

The protection which well distributed forests provide against strong winds is of great importance in Great Britain and Ireland. Such woods also provide breeding places for useful birds, the great insect destroyers in agricultural districts, though, in this respect, hedgerows are, perhaps, more useful. Nor should it be forgotten that woods provide considerable assistance in the defence of the country, as has been proved during the late war.

While the indirect effects of forests are frequently difficult to estimate, it is comparatively easy to assess the benefits which a country derives from woodlands through their produce. Some details have been given above of the variety of articles which forests yield, apart from timber and firewood. Some of these articles can be produced in this country, such as fruits, leaves, flowers, grass and grazing, all useful in husbandry in the poorer

districts; others are chiefly imported, such as rubber, gutta-percha, dye-stuffs, gums, turpentine, resin, pitch and tar, fibres, oils and others. The value of these imports into these islands in 1913 reached the enormous sum of £26,120,000.

Extensive areas are used in this country for the rearing of red deer, grouse, pheasants and even rabbits, the first two especially in Scotland. The forester is chiefly interested in rabbits, a plague which more and more endangers a rational utilization of the land. If a minute investigation were made into the damage done by rabbits, not only to forests, but especially to agricultural crops, people would be astonished at the amount. No doubt rabbits provide a certain amount of food, especially to the poorer classes, but that does not compensate for the damage done by them. Fortunately, as will be seen further on, the Forestry Act gives power to deal with the matter satisfactorily as far as forests are concerned.

No doubt, shooting rents are a convenient source of income. If, however, the areas are compared with the income derived from them, it will be found that the rent is not nearly as large as is sometimes assumed. On an average, shooting rents fall short of a shilling an acre; there are areas which yield half a crown, or even more, but there are also extensive areas which yield only a few pence an acre. On the other hand, much of the land can be made to yield a considerably higher return if put under forest.

The demand for firewood in this country is much smaller than in continental countries, where the supply of substitutes and the means of transport are less favourable. Before the war, the price of firewood in many parts of the country barely covered the cost of preparing it, and frequently not even that. During the war, the demand and the price increased very considerably. It was wanted not only for military operations, but also for domestic use owing to the shortness of the coal supply, as well as for the manufacture of charcoal, acetone and other substances. It is impossible to say what development in this direction the future may bring, but there will always be a considerable quantity of firewood available from coppice woods and all the parts of trees which are not fit for timber.

Although the requirements so far enumerated demand attention, the crux of the question of forestry is the supply of the

necessary timber and pitwood. It has been shown above that during the period 1909—1913, the average annual consumption of timber and pitwood amounted to about 11 million loads, of which about 1 million loads were produced in the country. It has also been shown that the future supply of the 10 million loads of imported timber rests on a very unsafe basis even in peace time. The great war, in proving that it was practically impossible to obtain the necessary timber from outside, brought it home to the nation that the time had arrived for the adoption of a decided forest policy. This led to the appointment, in July, 1916, of the Forestry Sub-Committee of the Reconstruction Committee, and the passing of the Forestry Act of 1919, to be dealt with in the following pages.

SECTION III.—THE FORESTRY SUB-COMMITTEE OF 1916-17.

The Forestry Sub-Committee consisted of fourteen members with the Right Honourable F. D. Acland, M.P., as Chairman. The terms of reference were :—

> " To consider and report upon the best means of conserving and developing the woodlands and forestry resources of the United Kingdom, having regard to the experience gained during the war."

After strenuous work extending over 10 months, the Committee submitted their report in May, 1917. The following pages give a contracted account of the report, with such remarks as the author of this book (a member of the Sub-Committee) considers desirable to add. The report served as the basis of the Forestry Act of 1919, which lays down the future forest policy of Great Britain and Ireland.

1. Introductory.

Already in the Middle Ages attempts were made to protect certain forests which, at that time, served principally as the hunting grounds of the King. During a long period, however, destruction of the forests was a prominent feature, and, as mentioned above, it was not until towards the end of the eighteenth century that the timber outlook became really serious. Arrangements were then made under which over 50,000 acres principally of oak woods were added to the Crown forests for the

future requirements of the Royal Navy. As it was found in the nineteenth century that oak timber was no longer required for the Navy, no further efforts of afforestation by the State were made.

About the year 1880 questions were raised as to the more profitable management of the Crown Woods, the utilization of waste lands and the more extended production of coniferous timber. A Parliamentary Select Committee investigated these questions, and suggested, in the first place, the establishment of a School of Forestry either on the lines of that at Coopers Hill, or in connection with it; also the establishment of a Forest Board to deal with educational matters. Practically, these suggestions were not carried out, but they were followed by a series of other Committees and Commissions, such as :—

The Departmental Committee of the Board of Agriculture, 1902.

The Departmental Committee on Irish Forestry, 1907.

The Royal Commission on Coast Erosion, 1909.

The Departmental Committee on Forestry in Scotland, 1911.

The Advisory Committee on Forestry, 1912.

The report of the Royal Commission of 1909 led to the establishment of the Development Commission.

It is not necessary to record here in detail the proposals made by the above-mentioned committees, but to state that the results were not up to expectations. Two schools for forest subordinates were established at the Dean and at Avondale in Ireland, and lectureships at several agricultural colleges and universities. In Ireland, forest surveys were started and some land for afforestation and some depleted forests acquired. A Railway Fire Act was passed. The Development Commission assisted to some extent education, research, experimental work, provided funds for advisory work on private estates, and gave some moderate grants to assist the afforestation of waterworks catchment areas. With the exception of Ireland no real progress was made in the afforestation of additional areas, except what was done by the Commissioners of Woods. The latter acquired the Clearwell and Tintern Woods, which, with the Dean and High Meadow Woods, represent a wooded area of over 17,000 acres; they also acquired the Inverliever estate of 12,000 acres in Scotland.

The author of this book took up the question of improved forestry and extended afforestation soon after his return from India in 1885, and placed his views before the public by writing, lecturing, and practical advice given to forest proprietors. In this task he was, after a time, followed by others, more especially by Dr. J. Nisbet and Mr. W. R. Fisher. Some progress, though slow, was made in drawing attention to the importance of forestry, and in 1895 the late Sir Stafford Howard, Commissioner of Woods, took up the task of improving the management of the Crown Woods. He had reports on the Dean and High Meadow Woods drawn up by a distinguished Indian forest officer, and in 1899 he appointed the first scientific forester to assist in the management of the Dean, High Meadow and Tintern Woods. Subsequently these woods came under the management of the scientifically trained Forestry Inspectors of the Board of Agriculture, who continued and further developed the system of management. These areas are now the most instructive forests in the country, and they show the paramount importance of entrusting the management of forests to scientifically trained men. They also prove that the State is quite capable of successfully carrying out schemes of afforestation and of providing effective management. Thus, by 1914, a considerable number of people had recognised the importance of the systematic management of forests and the necessity of a considerable extension of their area, but it required a further stimulus to convert this movement into action, and this was provided by the war.

2. Experience Gained during the War.

Within a month of the outbreak of the war, fears arose that the British coal mines might run short of pitwood, owing to the rapid reduction of the imports of such wood. Enquiries were set on foot to ascertain :—

(*a*) What quantities of home-grown pitwood were available.

(*b*) Whether the available amount was sufficient for the needs of the collieries until normal conditions would once more obtain.

The enquiries showed that the total existing quantity would be used up in about two years, exclusive of existing stocks and further supplies from outside. Soon afterwards timber for

general consumption also began to fail, and, above all, the requirements of timber necessary for an efficient conduct of the war assumed gigantic proportions. The submarine warfare interfered more and more with the imports of timber, especially from the Baltic. They reached in 1915 only 75 per cent. of those before the war, and sank to 63 per cent. in 1916. At the same time, prices rose enormously, so that the country had to pay £37,000,000 more for the wood imports during those two years than it would have paid before the war.

In the meantime the quantity of available shipping had rapidly decreased, and every possible step to increase the tonnage had to be taken. As the imports of timber required some 6 million tons annually, a quantity approximately equal to that required for the import of grain, it was decided, in January, 1917, to prohibit the import of timber except by licence, to obtain the timber required for home consumption chiefly from British woods, and that for the conduct of the war, as far as possible, from French forests. A timber supply department was established in France, and the home timber supply department thoroughly organised and considerably enlarged. Canadian lumbermen were obtained, men not fit for general service were transferred to forestry battalions, sawmills were hired and bought. The transport of the material presented great difficulty; there were no horses available, and mechanical traction difficult to obtain, owing to the large demand for military purposes; nor were the roads in many parts of the country sufficiently solid to bear the heavy traffic. The war found the home timber market in an unorganised condition and unable to meet efficiently the sudden demands made upon it.

3. Necessity of an Adequate Forest Policy.

What has been said so far justifies the following conclusions:—

(1) The supply of home-grown timber is altogether insufficient to meet, even in times of peace, the ever-increasing requirements.

(2) The supply of imported timber in the future is uncertain, and this is a grave source of weakness in time of war or any other emergency.

(3) Afforestation would increase the productiveness of large areas of land in the country, which are now little more

than waste land, and which would benefit a considerable part of the population if placed under forest.

These points show that the forest policy of the State in the past was inadequate. The following remarks will further strengthen this assertion :—

The surprise of the war has been the enormous amount of wood consumed by military operations. To carry this, as well as the timber and pitwood urgently wanted at home, required a very large amount of shipping which was urgently wanted for the transport of war material and food. Moreover, the timber could be procured only by a heavy loss due to inflated prices of freight and insurance, loss of cargoes sunk by the enemy and by depreciation of the rate of exchange. Owing to these difficulties and the urgent necessity of setting free the timber carrying shipping for other purposes, the Government was forced to prohibit the import of timber in 1917, except by special licence. The country was then forced to fall back on its own timber resources, and serious inroads have been made on British woods during the war, in fact, so much so, that, if the war had lasted another year, disastrous consequences would have resulted. Of hardwoods there is still a fair amount in the country, as, with the exception of ash, the demand for it was comparatively small, but the balance of coniferous timber fit to cut would not have been sufficient for even one year's requirements. Fortunately, the timber required for the front could be obtained from French forests. As a consequence, the people and the Government of the country recognised at last the necessity of immediate action, not only to restock the cleared areas but to increase substantially the area under wood, so as to have a considerably larger stock to fall back upon in the case of any future emergency.

Apart from the considerations so far mentioned, a policy of extended afforestation is justified and desirable on account of the substantial benefits which it confers on the people, especially in the sparsely populated districts, such as the Highlands of Scotland and the hilly districts of northern England, Wales and Ireland. In those parts large areas are now devoted to the rearing of sheep and deer, while the reclamation and equipment for agricultural operations is possible only if some other industry can be carried on at the same time, which provides occupation to the small

farmer and his family during winter when they would otherwise be idle. In these cases, forestry and the industries based on it can help. By afforesting mountain and heath land the amount of labour will be considerably increased as compared with light grazing, thus enabling the small holder to exist in decent comfort. Forestry fits in with farm work better than any other industry, as most of its work can be done in winter when the farm requires little attention. It should not be overlooked that afforestation can be made a means of dealing to some extent with the formidable question of the unemployed.

The question as to how far afforestation leads to an increase of national wealth deserves consideration. Such increase may be effected in a variety of ways, such as higher returns from the land, or, to express it differently, by a higher rate of interest yielded by the invested capital, by the increased safety of the country in case of an emergency, the more economic utilization of the land not required for agriculture or other useful purposes, the development of industries using forest produce as their raw material, the extra amount of work provided, the retention of capital in the country and, last but not least, the amelioration of the conditions of life in the poorer parts of the country.

4. Replacement of Imported by Home-Grown Timber.

Before formulating a new forest policy for the future, it is necessary to consider whether, and to what extent, home-grown timber can be substituted for imported timber.

An analysis of the official returns of timber imported in 1913, the last complete year before the war, shows that the main classes of timber were represented in the following proportion :

Coniferous timber	60·2 per cent.
Pitwood	29·8 ,,
Oak timber	2·2 ,,
Staves, big and small	1·6 ,,
Teak, Mahogany and Fancy Woods	3·8 ,,
Miscellaneous timbers	2·4 ,,
Total	100 ,,

Coniferous timber and pitwood together amounted to 90 per cent.

of the imports, and these can all be replaced in Great Britain and Ireland by larch, pines, spruces and firs. Oak, ash and some other species included under Miscellaneous Woods can also be grown at home. On the other hand, teak, mahogany, and most of the fancy woods come from tropical countries. Wood pulp is made almost entirely of spruce and pine, and it can be prepared from home-grown material.

It has been said that home-grown timber is of inferior quality compared with that of the same species imported from abroad. As to the quality of home-grown oak and ash, it is well known that it is at least equal to that of imported oak and ash, and in many cases superior. The same holds good in the case of beech and larch. It is true that inferior spruce and pine has frequently been produced at home in the past, but it is equally true that this was the result of faulty silviculture. Thinnings during the first half of the life of the woods were too heavy, and pines were, in the majority of cases, cut before they had formed heartwood. More rational treatment will remedy this. The greatest obstacle to successful forest production in Great Britain and Ireland is the westerly, and especially south-westerly, winds, but proper treatment modifies the effect of these winds very considerably. Woods should never be opened out on the side whence the prevailing winds blow, but on the opposite side.

On the whole, it may be said that the question of reducing Britain's dependence on imports of timber and wood derivatives depends on the area of land available for afforestation and the will of the nation to plant it. The chief difficulty in the way of afforestation is the fact that the bulk of the mountain and heath land is private property. In some cases proprietors are not inclined to plant, and in others they cannot afford to meet the initial expense of planting, or to forego the present small income from the land until the plantations begin to yield a return. In these circumstances three ways of meeting the difficulty present themselves :—

(*a*) The State may encourage afforestation by private proprietors by giving them financial assistance when necessary.

(*b*) Municipalities and other corporations may acquire land and convert it into corporation forests.

(*c*) The State may acquire land, either by purchase or long lease, and afforest it.

All three agencies should be put into motion, and the State should ordinarily restrict its action to that part which private proprietors and corporations are unable or unwilling to undertake.

There remains, however, the financial aspect of the undertaking. In this place attention will be drawn to one fact, which has been somewhat overlooked: The price of imported timber fell from 1871 to 1884 in consequence of the development of trade generally and the rapid increase of the mercantile fleets. From 1884 to 1892 prices kept, with some oscillations, on about the same level. Then a rise set in which lasted until the outbreak of the war; during that period the average price of coniferous timber and pitwood rose by 30 per cent. of the price in 1892. At present prices are abnormally high, and so is that of labour. What the price of both may be when the effect of the war has disappeared it is impossible to say, but there cannot be any doubt that they will rise and fall together and in due proportion. These variations will have no effect in the long run on the financial aspect of forestry, and intending planters need not have any fear as regards high wages of labourers, because they will be compensated by corresponding higher prices of timber.

5. The Forest Policy of the Future.

The forest policy of the future must be based on the facts that the present production of home-grown timber is altogether insufficient, that the prospect of obtaining future supplies is uncertain, and that in the case of any future emergency security can be obtained only by having a sufficient stock of timber at home.

The problem of providing adequate home supplies is divided into two parts:—

(*a*) The improvement of existing woods including the replanting of the areas cleared during the war.

(*b*) The afforestation of additional areas.

Beginning with the existing woods, which covered before the war just over 3,000,000 acres, it is stated that about 300,000 acres were cleared during the war, so that, for some time to come, the annual yield will be much below even the small figure which it had reached before the war. Not only have mature crops been felled in all parts of the country, but many thousands of acres of young immature woods have been cleared for pitwood and other purposes

or have been thinned to a degree which renders clearing and replanting essential. All this refers to coniferous woods. Hardwoods, especially those of oak, have experienced less drastic treatment. Under these circumstances, the existing woods, even under systematic treatment, could not provide the necessary timber to meet periods of national emergency. These woods yielded before the war about 47,000,000 cubic feet annually, or about 15 cubic feet per acre and year, and in their present condition they are not likely to reach, for a considerable period of time, a yield of more than 30 to 40 million cubic feet annually, even under proper management. This small production it is considered advisable to allot to meeting any further increase in the demand for timber, and to leave it out of consideration in calculating the area of new afforestation.

The average annual imports of wood (timber and pulp-wood calculated as growing crops) during the years 1909 to 1913 which could be grown in Great Britain and Ireland were as follows :—

	Cubic Feet.	Total.
Conifers :		
Unconverted timber . .	175,000,000	
Converted timber . . .	360,000,000	
Pulpwood	85,000,000	
		620,000,000
Hardwoods :		
Unconverted Oak and others .	10,000,000	
Converted	8,000,000	
		18,000,000
Grand total, Conifers and Hardwoods. .		638,000,000

To provide all this wood, the following areas will be required. The Sub-Committee estimated the yield, final cuttings and thinnings, in the case of conifers at 70 cubic feet annually per acre of afforested land, and at 35 cubic feet in the case of hardwoods. Hence, the required areas would be :—

		Acres.
For Conifers .	620,000,000, divided by 70, equal to	8,857,143
For Hardwoods .	18,000,000 ,, 35 ,,	514,286
Total area to be afforested		9,371,429

which would be equal to 12 per cent. of the total area of Great Britain and Ireland. The two classes of timber stand, however, on a different footing.

Dealing first with conifers, the Sub-Committee pointed out that there is no necessity to provide a home supply of 620 million cubic feet annually, as in normal times imports may come in as before the war; all that the country requires is to have sufficient timber at home to make the country safe in time of an emergency. Whatever the area under systematic management may be, the different age gradations will always be represented running from one year up to the age of rotation, say 80 years. In normal times the oldest gradation, 80 years old, is cut every year, but in a case of emergency more than one gradation may be cut, say, up to five, and this might be repeated for, say, 3 years, making the country safe for 3 years. There would then be left a series of age gradations running from 1 to 68 years old. The deficiency in the normal stock could then be replaced by cutting below the normal yield for some years after the emergency period is passed. In adopting such a system, only one-fifth of the above-mentioned area will be required to make the country safe for 3 years.

The case of hardwoods is different. While the afforestation of conifers will be effected on land which is not fit or wanted for the production of agricultural crops, hardwoods require as a rule better land than conifers, and, apart from the area already under wood, little land of the desired quality is obtainable without encroaching upon agricultural land. A limited amount of hardwood must be grown with conifers for silvicultural and protective reasons, but that rarely reaches proper timber size and quality. Under these circumstances the State should buy woods and especially devastated or cleared areas, and manage them for the production of hardwoods on the principle of a sustained yield.

The required areas would thus stand as follows:—

	Acres.
Area to be afforested with Conifers	1,770,000
Area required for the production of Hardwoods .	100,000
Total area to be afforested	1,870,000

If it should be considered necessary to make the country safe for a longer period than 3 years, the area to be afforested would have to be correspondingly increased.

Under a rotation of 80 years for conifers, theoretically one-eightieth of the area should be planted every year, but as the remaining stock of timber has sunk to a very low figure, the Sub-Committee proposed to plant two-thirds of the total area during the first 40 years, leaving one-third for the second half of the first rotation. For hardwoods it is sufficient to afforest at the rate of 1,000 acres annually. It is thus proposed to plant during the first 40 years 1,180,000 acres with conifers and 40,000 acres with hardwoods. It is further pointed out that caution during the early years of the operations is highly desirable, and that, therefore, the planting during the first 10 years should be reduced from the normal amount of 295,000 acres to 200,000 acres, in addition to pushing on the replanting of areas cleared during the war. What the latter area may be cannot be stated at present, but the Sub-Committee hopes that it will not be less than 50,000 acres. The deficiency of 95,000 acres can be made good in the second period of 10 years.

Hedgerow timber has not been dealt with by the Sub-Committee. It is closely connected with agriculture and left to that Department to deal with, at any rate for the present.

In selecting the areas required and available for afforestation it should be understood that, excepting small areas for the production of hardwoods, no land fit or reclaimable for agriculture should be planted. It may even be possible to bring areas which are now too isolated into cultivation in connection with afforestation. The Forest Authority must look to land classed as mountain and heath land, of which the following areas exist :—

	Acres.
In Great Britain	12,801,974
Add area of deer forests	3,519,678
	16,321,652
Deduct land over 1,500 feet elevation considered unplantable	3,537,172
Balance available for selection . . .	12,784,480

Two-thirds of the area are situated in Scotland. From this area large deductions must, however, be made on the basis of detailed investigations in Dorset and Hampshire, in Glen Mor in Scotland, and in the west of Scotland, by excluding poor tillage lands, deep peaty soil, rocky surfaces, exposed positions, &c. After making very liberal deductions in this way the Sub-Committee were satisfied that there are certainly between 4 and 5 million acres of planting land available, including some 500,000 acres in Ireland. This area is more than double that which it is proposed to plant during the next 80 years.

The allocation of the land to be afforested in England, Wales, Scotland and Ireland must be left to the Forest Authority, but as the main argument for afforestation centres in the defence of the country, it is necessary to record certain aspects of the task. The nearer the growing wood is to the place of consumption, the less labour and transport is required. In normal times large manufacturing and mining centres are the chief consumers of timber, and, other things being equal, the forests should be as near to them as possible. Another important point is that enormous quantities of wood are required in modern warfare, which makes it essential that supplies should be available within reasonable distance of the firing line. Nor should it be forgotten that forests have great value in the defence of the country. All these, and other, considerations make it essential to distribute the forests as evenly as possible over the country. It follows that the new forests should not be concentrated too much in one of the Kingdoms, or in a limited number of districts, but that they should be distributed as evenly as the presence of suitable land permits. The initial outlay may be increased somewhat, but the timber will presumably be close to the centres of utilization and therefore have a higher value.

6. Methods of Afforestation.

The land to be afforested and the bulk of the land to be replanted are private property, and it is highly desirable that as much as possible of the afforestation should be undertaken by the proprietors of the land, that is to say, by private owners and corporations, while the State should do that portion which the other agencies decline or are unable to undertake. In view,

however, of the urgency and importance of the matter, it is highly desirable that the State should show the way by afforesting the main part of the 200,000 acres to be planted during the first 10 years, thereby stimulating and encouraging private proprietors to do likewise. Too much should not be expected from the latter during the first years, but it is hoped that private participation will increase as the work proceeds; in the same degree as that increases, the amount of afforestation by the State can be decreased. That process may be accelerated by monetary assistance to private proprietors or by a co-partnership of private proprietors and the State, as will be explained further on. The Sub-Committee estimated the following division of the work during the first 10 years :—

	Acres.
Afforestation by direct State action . . .	150,000
Afforestation by Co-partnership . . .	25,000
Afforestation by Corporations and Private Owners	25,000
Total new afforestation . . .	200,000
Replanting of cleared areas by proprietors . .	50,000
Grand total of operations during first 10 years .	250,000

Afforestation by the State.—In so far as State or Crown lands are not available, the necessary area must be acquired, either by purchase or long lease. In selecting the land to be acquired, care should be taken to ascertain whether a sufficient area is obtainable in any district to form an administrative and silvicultural unit, and to arrange the sequence of planting operations accordingly. It is, however, not necessary to disturb the present holders of the land for more than one or two years ahead of the actual planting.

Purchase of land is necessary when the required area cannot be obtained in any other way. It involves a heavy outlay at starting, and it has, therefore, been proposed to try renting the land on a long lease, which should run for not less than one rotation. If this scheme succeeds, the immediate outlay would be greatly reduced; nor would it be necessary to secure land more than four years ahead of planting. To induce proprietors to lease land for afforestation, they might be given the right of

taking over the wood at any time at a satisfactory valuation of the outlay, with interest, on the part of the Forest Authority.

It is desirable that as much as possible of the required land, whether by purchase or lease, be secured by voluntary contract, but power of compulsory acquisition must be given to the Forest Authority, so that a single owner may not hold up the development of a scheme that has been undertaken.

The Method of Co-Partnership.—It is proposed that the owner should provide the land and the local management, while the State would contribute the money for the cost of afforestation and control the management; the net receipts would then be divided equitably according to the amount of capital put in by each partner. The advantage on the part of the State would be that the immediate outlay would be much reduced as compared with direct purchase, that the experience and local knowledge of the landowner would be utilized, and that the number of men in direct State employment would be much reduced. The advantage on the part of the landowner would be that he retains possession of the land, and that the experience and expert advice of the Forest Authority are at the back of the venture, which might incline him to take a risk otherwise inexpedient to him. The Sub-Committee was hopeful that this system would be successful.

Afforestation by Local Authorities.—Many large cities have become the owners of considerable tracts of land which serve as the catchment areas of their water supply. The best way of utilizing these lands is to put them under forest, as this tends to equalise the run-off during the different seasons of the year and to fix the surface soil, thus reducing the amount of silt carried into the reservoirs. It should be the rule that in catchment areas all suitable land will be afforested, and that local authorities should be eligible to receive assistance from the State in the same way as private proprietors.

Attention should also be drawn to the value of forests as recreation grounds, especially in the neighbourhood of the towns. The shade in summer and the protection against cold winds render forests in this respect more serviceable than open parks, while the use by the public need not appreciably reduce the return of timber and other produce derivable from the areas. The establishment

of such recreation grounds should be encouraged by local authorities and the Forest Authority of the country.

Assistance given to Private Proprietors.—Although it is essential that a certain proportion of the forests should be the property of the State as a safeguard in the case of an emergency, the afforestation by private landowners is really of the first importance in the case of Great Britain. The Sub-Committee paid, therefore, special attention to the question of giving suitable assistance to private landowners, to induce them to plant. After careful consideration, the Sub-Committee decided to offer a contribution of about half the cost of planting, that is to say, £2 in the case of conifer plantations, and up to £4 in the case of hardwood plantations, per acre. These were appropriate rates before the war, but they have been upset, at any rate temporarily, by the enormous increase in the cost of labour and the rate of interest at present obtainable from safe investments. That interest has risen to 6 per cent. against about half the amount before the war. Under these circumstances, not much progress in planting by private landowners can be expected just at present, and until the cost of labour and rate of interest have once more approached normal conditions.

Instead of a contribution to the cost of planting, the assistance may take other forms, such as loans at a somewhat reduced rate of interest, relief from public burdens and taxes during the early years of the forest's existence, &c. In all these cases the total value of concession should not exceed the sums of £2 and £4 respectively given above.

The grant of assistance would, of course, be conditional to a certain control by the Forest Authority, such as the selection of the land to be planted, approval of the working plan, and an undertaking that the wood is maintained for a minimum number of years, say 30, so that the State may derive some benefit from the planting.

7. Replanting of Areas cleared during the War.

The replanting of areas cleared or devastated during the war is of the greatest importance. The area felled during the war is at present estimated at about 300,000 acres, and the Sub-Committee considered the question of compulsory replanting by the

owners, on the ground that the proprietors had received much higher prices for the timber than they would have obtained in ordinary times. This was, however, not the case in all instances, and, considering the moderate yield of most of the woods before the war, it is very doubtful whether any of the proprietors realised more than a fair return on their previous outlay. It should also be remembered that it would be an unsound policy to attempt the immediate replanting of the large areas, from which coniferous timber has recently been felled, on account of the danger from insect pests. Under these conditions the Sub-Committee considered it unwise to employ immediate compulsory methods, but they drew attention to the fact that the State can take any necessary measures, when considering the general question, whether an owner is making the best use of his land in the national interest. If land previously under timber is not put to better use, the onus will be upon the owner to show why it should not again be put under timber. This will act as an indirect compulsion to replant all the areas which cannot be used to greater profit in some other way. In the meantime the Sub-Committee recommend that grants up to the maximum of £2 and £4 respectively made for planting new ground with conifers or hardwoods, should also be admissible in the case of clear-felled and devastated areas, each case being considered on its own merits.

8. Afforestation and Employment.

The scheme of State afforestation recommended by the Sub-Committee begins with the planting of 3,300 acres in the second year, to be increased by regular steps to 30,000 in the tenth year. Assuming that, on an average, one man will be required for each scheme involving the planting of 10 acres per annum, the number of men permanently settled on the land would be 330 in the second year and 3,000 in the tenth year, in each case exclusive of supervision.

After the plantations have been established, and up to the fifteenth year, they require comparatively little attention, consisting of weeding for 2 or 3 first years after planting, and occasional repairs of fences and drains. From about the fifteenth year onwards the plantations require to be thinned, first lightly and gradually more strongly; roads will have to be made and

the material obtained from the thinnings prepared and hauled to the market or railway station, so that the amount of labour will steadily increase. By the fortieth year it may be found advisable to begin, on a small scale, the clear-felling of the first planted areas. Timber fit for sawing would begin to be cut about 10 to 15 years later, and by the eightieth year the forests should be in full yielding. The Sub-Committee estimated that then about one man will be permanently required for every 100 acres (the author thinks that 75 acres is nearer the mark) for all work to be done inside the forest. The conversion of timber will give employment to about the same number of men as the forest itself. The running of the total afforested area of 1,870,000 acres would thus employ 18,700 men. Deducting 2,000 sheep farming men displaced by afforestation, the net gain would be 16,700 men, and if the conversion of timber and wood manufactures are added the net gain amounts to about 33,400 men. If 25,000 families supply that number, about 125,000 persons would be provided for, living under healthy conditions with continuity of steady employment.

Whether, and to what extent, afforestation can be utilised to meet periods of unemployment, is perhaps difficult to say. Schemes of afforestation to be successful, must be carried out according to a set plan, but it may be possible to expand planting operations for a limited period without seriously upsetting working plans ; the area to be planted could be doubled for 3 or 4 years, or roads could be constructed in advance, thus providing extra work for unemployed men. This plan has since been adopted.

On the other hand, afforestation offers an opportunity for the settlement of demobilised soldiers. The number of men who can be permanently settled under the proposed scheme depends on the rate at which it develops. There would be room for 330 men in the first year, rising by degrees to 3,000 in the tenth year. If required, it would be easy to speed up operations so as to accommodate a larger number at the outset.

9. Afforestation and the Food Supply.

The afforestation of grazing lands would result in a reduction of the food supply, which the Sub-Committee estimates at perhaps

10 lb. per acre a year, and, in the case of deer forest land, at 2 lb. annually per acre. This would cause a loss of about 0·4 per cent. of the total meat requirements of the country. The withdrawal of 1,770,000 acres would be gradual and spread over a period of 80 years, thus causing a sacrifice so diminutive that it cannot be considered when compared with the object in view of making the country self-supporting in timber in an emergency like that of the recent war.

10. The Promotion of Silviculture.

The Sub-Committee has made proposals under a variety of heads, which will, in this place, only be mentioned shortly.

Surveys are necessary towards the institution of schemes of afforestation. Some progress has already been made with the inspection and classification of uncultivated lands, but the work requires speeding up, and it should ultimately be extended to include all woods.

The Office of Woods and the Board of Agriculture have sown considerable quantities of seed, and lined out the resulting seedlings in extensive nurseries. This work is to be steadily continued, so that operations can now be commenced and gradually extended as indicated above.

For carrying out the scheme proposed by the Sub-Committee, three classes of officials will be required, forest officers, foresters, and foremen. Some men of the first class are available; additional men will pass through a special forestry course at one of the recognised universities, and their practical training should be given a distinctly British bias, to which visits to instructive continental forests should be added. The Sub-Committee points out that there are at present more schools of forestry of the university type than are necessary to train all the officers required for the British Empire, and that this involves a great waste of money; hence, the Forest Authority should select one or perhaps two, of the best schools for the instruction of their cadets and assist them in making the instruction as complete and suitable as possible. For the purpose of practical instruction, the Forest of Dean, the High Meadow Woods and the Tintern Crown Woods are rapidly becoming good demonstration areas. Others will be added as the work proceeds. After all, the best demonstration

areas are forests managed according to correct silvicultural principles. There is, unfortunately, no demonstration area in Scotland. Students from Scotland should, for the present, make use of the above-mentioned areas in England.

The Sub-Committee proposes that the foresters and foremen should be recruited by taking young men at the age of 18 or 19 into elementary forestry schools. It is desirable that these men should have had some experience of woods. The schools should be open to young workmen, who have attended continuation or secondary schools. All would enter the forestry school as workmen and receive wages, performing the ordinary operations of forestry, and receiving instruction during six months. Those who have proved to be intelligent and energetic will be allowed to attend further courses for 18 months. Some of the latter would, at the end of the two years' course, be fit for immediate appointment as foresters, others would obtain such appointments after further experience as foremen, others would remain foremen, others might be kept on as skilled woodmen. Several schools suitable for the training of these men already exist, and others will be organised as required. It is essential that men sent by private proprietors should be admitted to these schools.

The methods prevailing in British forestry in the past have yielded a considerable amount of experience of what, and how, to do, as well as what, and how, not to do. The experience thus gained will enable the Forest Authority to commence operations in a rational way, but the further development of silviculture requires a considerable amount of laboratory research and experiments in the forest. On the intelligent prosecution of these will depend the ultimate success of the scheme of improving existing woods, creating and tending others, and the adoption of the best method of treatment. Forestry can as little do without continual research as any other branch of industry. The various problems awaiting research and experiment in the woods are too numerous to be dealt with in this place; they all tend towards providing the most favourable conditions for a healthy and vigorous development of the growing woods, such as the action of different soils on tree growth, the effect of climatic conditions, the damage likely to be done by insects and fungi, the rate of growth, the quality of timber and endless others.

The Sub-Committee recommend the continuance of the advisory system introduced in 1912 in England and in 1917 in Scotland, by appointing officers to advise private proprietors on the management of their woods. In Ireland the regular forest officers of the Board of Agriculture have done similar work. The measure has produced good results in the past in promoting a wider understanding of scientific forest management.

11. Public Burdens resting on Woodlands.

It is stated that woodlands may be subject to one or all of the following burdens :—

(*a*) Local rates.
(*b*) Income tax, including super-tax.
(*c*) Death and succession duties.
(*d*) Excess profit tax.
(*e*) Land tax, tithe rent and similar charges.
(*f*) Special payments in respect of extraordinary traffic on public roads.

This is not the place to deal in detail with the different burdens ; the following short notes will suffice. Some of the items, as (*c*) and (*d*), are not peculiar to forestry, but apply to all sorts of property, and they need not be considered here. Local rates and land tax differ practically from place to place. Special payments in respect of extraordinary traffic are altogether an unjust charge, because woodlands pay taxes over the whole lifetime of the wood, whether there is any traffic over public roads or not. By demanding extra payment when the wood is cut over, the proprietor is asked to pay road cess twice over.

There is only one just method of assessing taxes on woodlands, namely, to calculate the tax on the basis of the net income which the woodland is capable of yielding. That basis should be utilized for the assessment of both income tax and local rates. Fortunately the Revenue Authorities have recognised the justice of the method by allowing forest proprietors to be assessed under Schedule D, which proprietors should do. Under this system an account is kept of all outlay and income, the tax being calculated from the difference of the two. The taxation under Schedule D. has, however, drawbacks, as it now stands. A proprietor may spend more money than is necessary, and the management may

be so inferior that the returns are lower than they should be. When the new Forest Authority has time to take up the question it may be possible to draw up tables based on average results, giving the net yield which woods can give if managed according to sound silvicultural principles, on which taxation can be based. Such tables should be graded according to quality classes of locality and species.

12. Railway Rates.

The high cost of transporting home-grown timber by rail has been the source of many complaints by timber growers. They argue that timber is deserving of a lower classification than that actually assigned to it, that imported timber receives more favourable consideration, and generally that rates should be reduced to a level permitting home-grown timber to compete in the open market with imported material. To these arguments the railway companies answer that home-grown timber is placed on rail intermittently and in small lots, that it takes up much space in proportion to its weight, and that the maximum rates fixed by Parliament have not been exceeded. The Sub-Committee believed that the timber industry has been unduly hampered by railway rates, and that large quantities of valuable home-grown timber fail to reach their most useful market owing to the heavy railway charges. The question is, however, beset by considerable difficulties, especially at the present time. It should be inquired into in any case, as it is highly desirable that rates should, if possible, be granted between the main producing and consuming centres which would make timber growing fairly remunerative. Time will, no doubt, remove one difficulty. In the same degree as silviculture improves, will the main argument of the railway companies disappear. Timber will be produced which in shape resembles that now imported from abroad; it will pack better and be delivered on rail in larger quantities and at regular intervals.

13. Organisation of the Timber Industry.

The difficulty of improvising in time of an emergency like that of the late war an organisation to provide increased home supplies

of timber was due to the disorganised state of the home timber market in the past. This must be changed in the future ; there must be close and systematic co-operation between growers and dealers, and the State should assist and encourage them in every possible way. Producers should ensure regularity, continuity and uniformity of supplies, so that dealers and consumers may know when and in what quantity and shape timber is coming into the market. The prejudice against home-grown timber will then gradually disappear, and it will be used for many purposes for which it has been rejected in the past. In the latter respect, Government departments have much sinned. The Sub-Committee was of opinion that the Forest Authority should include in its organisation an Intelligence Branch, to deal with questions relating to the organisation of the home timber trade, the methods of improving the utilization of forest produce, and generally the issue of information which would be useful to owners of woodlands and to users of timber.

14. Encouragement of Woodland Industries.

The Sub-Committee has quite rightly drawn attention to the importance of industries which use wood for their raw material and especially those parts of wood growth which cannot be classed as timber in its narrower sense. They are principally the produce of coppice woods and the small pieces which remain over in the process of timber conversion. Such industries, if properly organised, provide a considerable amount of remunerative work, and they prevent the wastage of a large percentage of the wood increment produced in the forests. Industries of this kind existed before the war in various parts of the United Kingdom, as, for instance, in the Chiltern Hills, the Tintern Crown forests and in other places. Wood distillation was carried on which yielded a variety of produce ; tools of various kinds and shapes were manufactured, but the greater part of such articles were imported from Germany, Austria and the United States. An effort should now be made to produce them at home, preferably by private enterprise and, if necessary, assisted and encouraged by State action. The care of the woodland industries should be committed to the Intelligence Branch of the new Forest Authority.

15. The Financial Aspect of Afforestation.

Although the main object of afforestation is to make the country safe in case of an emergency, the Sub-Committee considered it desirable to deal shortly with the financial aspect of the undertaking.

The profit or loss of afforestation is, naturally, represented by the difference between the returns and the costs of producing them. The latter consist of the interest on the value of the land, the cost of planting, and the expenses incurred in tending the woods while growing. The receipts depend on the quantity and quality of the timber and other produce valued as standing in the forest, in other words, the market value minus the cost of cutting and preparing it for the market. The items of receipts and expenses occur at various times spread over a whole rotation; hence the calculation of profit or loss must be made for one and the same moment, and compound interest must be allowed for all items, income as well as outgoings. The best time to make the calculation is at the commencement of the rotation when, it is assumed, the soil has been acquired. In the case of new plantations, the value of the soil and the cost of planting can be ascertained with fair accuracy, but all other items of receipts and expenditure are more or less problematic; they can be estimated only on the basis of past experience. The difficulty of the forester is much reduced if he has at his disposal suitable yield tables, which represent averages for the several soil classes and species. The data in such tables are generally given for fully stocked areas.

The Sub-Committee adopted the following method * of calculation :—The Cost value of the soil, Sc, is ascertained in the year o, when operations are commenced. This value is placed equal to the Expectation value of the soil, Se, calculated for the year, o, from all receipts and expenses, giving the following equation :

$$Sc = \frac{Yr + Ta \times 1{\cdot}op^{r-a} + Tb \times 1{\cdot}op^{r-b} + \ldots \ldots + Tq \times 1{\cdot}op^{r-q} - c \times 1{\cdot}op^{r}}{1{\cdot}op^{r} - 1} - \frac{e}{o{\cdot}op}$$

* The Method was evolved and published by the author of this book, in 1904, in a pamphlet entitled "Forestry in the United Kingdom."

where Yr represents the value of the final yield in the year r; Ta, Tb . . . Tq the values of thinnings, &c., in the years a, b, . . . q, c the cost of formation; e the annual expenses for administration, &c.; and p the rate of interest, under which Sc is equal to Se. The object is to determine the value of p corresponding to a certain cost value of the soil which is the average rate of interest yielded by the invested capital. It changes with every change in the value Sc of the soil.

Unfortunately, the above equation is mathematically not soluble, so that a graphical solution must be resorted to. Different values of p are introduced into the right side of the equation and the corresponding values of Se ascertained. These values are plotted and a curve drawn through them, from which the per cent. corresponding to different cost values of the soil can be read off. It is, of course, necessary to construct a curve for each species or even for each quality of soil, though that is, to a large extent, expressed by the cost value of the soil. The Sub-Committee were satisfied to make the calculation for a soil of average quality for each species. It selected the five species which are likely to be planted on a large scale, and determined the following matters for each of these species :—

(1) Length of rotation for Douglas fir (green variety), 60 years; larch, 70 years; Sitka spruce, 70 years; Scots pine, 80 years; and Common spruce, 80 years.

(2) The quantity of timber likely to be produced by each species in the course of one rotation on fully stocked areas managed according to efficient silvicultural rules, that is to say, under a 100 per cent. efficiency. The data were obtained in the following way : For Scots pine and spruce from statistics collected and tabulated in continental yield tables, modified by measurements made in this country and by local experience; for larch and Douglas fir from measurements made in this country; for Sitka spruce from a comparison with common spruce and the somewhat meagre records available in this country.

(3) The average prices obtained for the different classes of timber immediately before the war.

(4) The average cost of plantations before the war, £5 10*s.* per acre.

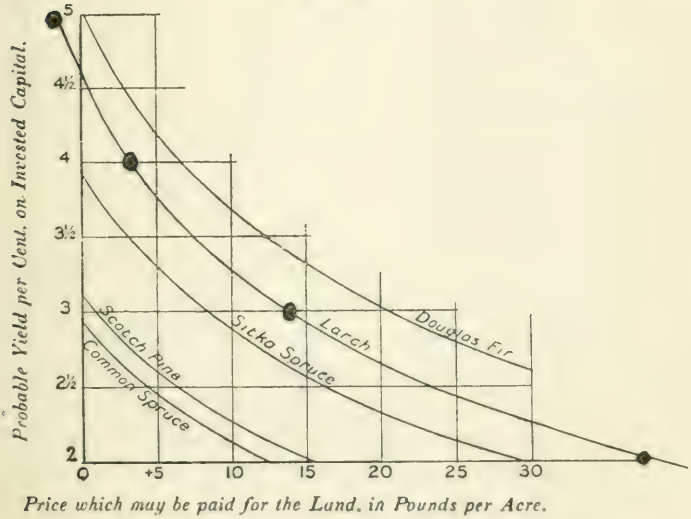
(5) The cost of administration and protection, 4*s.* per acre and year.

(6) The cost of construction and maintenance of forest roads and other improvements, 2*s.* per acre and year.

(7) Taxes were assumed to be covered by shooting rents, and both items were omitted from the account.

With these data the value of *Sc* for the different species and

Fig. 1.



different per cents. was calculated on what may be called the maximum or 100 per cent. efficiency scale. It was, however, pointed out that such high efficiency cannot be expected in actual work, and the Sub-Committee decided to be satisfied with a 70 per cent. efficiency. Accordingly, the data of yields were reduced by 30 per cent. and a fresh set of calculations of *Sc* with different per cents. made. With the results the appended curves were constructed. (See example for larch below.) From these curves the values of p for successive values of the cost of the soil were read off and placed in the following table :—

RELATION BETWEEN THE COST PRICE OF LAND AND THE CORRESPONDING INTEREST PER CENT. REALISED ON THE INVESTED CAPITAL—70 PER CENT. EFFICIENCY.

Cost of Land	Douglas.	Larch.	Sitka Spruce.	Scots Pine.	Common Spruce.	Average.
£ Per Acre.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
1	4·8	4·4	3·8	3·0	2·8	3·8
2	4·6	4·2	3·6	2·9	2·7	3·6
3	4·5	4·0	3·5	2·8	2·6	3·5
4	4·3	3·9	3·4	2·7	2·5	3·4
5	4·2	3·8	3·3	2·6	2·5	3·3
6	4·1	3·6	3·2	2·5	2·4	3·2
7	4·0	3·5	3·1	2·5	2·3	3·1
8	3·9	3·4	3·0	2·4	2·2	3·0
9	3·8	3·4	3·0	2·3	2·2	2·9
10	3·7	3·3	2·9	2·3	2·1	2·9
15	3·3	2·9	2·6	2·0	1·9	2·5
20	3·0	2·6	2·3	1·7	1·6	2·2

In the above table the average per cent. has been calculated on the assumption that one-fifth of the area is planted with each of the 5 species. If more than one-fifth is planted with the better paying species, Douglas and larch, the average can be considerably increased. The author is also of opinion that a 70 per cent. of efficiency is somewhat low, and that it might well have been raised to 75 or 80 per cent. He is of opinion that on soil worth not more than £5 an acre the average result should reach 4 per cent. under systematic and economic treatment.

The above calculations have been made with pre-war prices, namely, the value per cubic foot of a mature crop of larch at 12 pence, Douglas and Scots pine at 8 pence, Sitka and common spruce at 6 pence. It has also previously been stated that the price of timber has steadily risen between 1892 and 1913 by about 30 per cent. During the war prices rose enormously, but they are sure to fall again, though not likely to the pre-war rates. Wages are at present so high that they might well frighten the landed proprietors, but they also will come down again to more normal rates, a process which has already commenced. At any rate, it may safely be said that wages and prices of produce will

be sure to rise or fall in due proportion, so that these changes should not, in the long run, seriously affect the rentability of the forest industry. It cannot, however, too earnestly be impressed upon planters that the strictest economy should be practised in all forest business. Extravagance has no place in economic forestry. A rise of even 1 penny per cubic foot of timber, brought about by more economic management, would considerably raise the forest per cent., amounting in the case of spruce, for instance, to some 16 per cent., quite apart from any general rise in prices.

Example of Calculation for Larch.—The following table gives the returns from larch grown on land of average quality under a rotation of 70 years :—

Age of Wood.	Character of Felling.	Quantity, cub. feet, 70 per cent. Efficiency.	Value per c. ft. Standing, pence.	Total Value, Shillings.
20	Thinning .	105	6	53
30	,, .	210	6	105
40	,, .	350	7	204
50	,, .	350	8	233
60	,, .	280	9	210
70	Final Yield.	2,450	12	2,450
	Total Yield.	3,745		3,255

Calculation made with 2 per cent. :—

$$Sc = \frac{2{,}450 + 53 \times 1{\cdot}02^{50} + 105 \times 1{\cdot}02^{40} + 204 \times 1{\cdot}02^{30} + + 233 \times 1{\cdot}02^{20} + 210 \times 1{\cdot}02^{10} - 110 \times 1{\cdot}02^{70}}{1{\cdot}02^{70} - 1} - \frac{6}{0{\cdot}02}$$

This gives Sc = £40 19*s.* ; in other words, If the planter is satisfied with 2 per cent. interest on his invested capital, he can afford to pay £40 19*s.* for each acre of land. By making the same calculation with 3, 4 and 5 per cent., the following values are obtained : With 3 per cent., £14 4*s.* 9*d.* ; with 4 per cent., £3 2*s.* 8*d.* ; with 5 per cent., —£2 2*s.* This shows that, under the given conditions, 5 per cent. is not attainable. Even if the soil value was *nil*, not more than 4·6 per cent. could be obtained. The points indicated by these values have been marked by black

dots on the above illustration. A higher degree of accuracy in drawing the graph is obtained by calculating also the values for intermediate half per cents.

16. Establishment of a Forest Fund.

The Sub-Committee estimated that a sum of £3,425,000 will be required to meet the expenses of the first 10 years. This amount should be paid into a Forestry Fund, upon which the Forest Authority would draw according to requirements, subject to Parliamentary control. As this estimate was based upon pre-war prices, the above-mentioned sum will not suffice to carry out the proposed scheme ; it will have to be contracted unless additional credits are sanctioned.

The cost of the whole scheme was estimated to amount to £15,000,000 at pre-war prices, spread over 40 years, when the Department would become self-supporting. That sum is equal to about one-fifth of the extra cost of the timber required during the war.

17. The Forest Authority.

At first sight it might be considered that Agriculture and Forestry should be administered by the same authority, as they are on an ordinary estate. In such cases, a certain part of the area is kept under wood, with the primary object of providing the necessary amount of forest produce for the estate, any surplus being disposed of. Such a combination has the further advantage that, as already indicated, the same labourers can be employed throughout the year, from spring to autumn on field work and during the winter on forest work. At the same time there are great differences between the two methods of soil utilization, which have been explained in the early part of this book. The chief difference lies in the fact that, while in agriculture, the crops mature within 1 or 2 years, in forestry sowing and harvesting are separated by a long series of years, which may amount to 100 years and more. Hence, the forester must elaborate plans for the management of the woods for long periods of time. In the case of a large scheme, like that here under consideration, many practical difficulties present themselves. If there were one agricultural department in the United Kingdom, it might have

been possible to attach to it a strong Forestry Branch, the head of which would deal direct with the Minister of Agriculture, but there are three such departments, each independently responsible to Parliament through a different Minister; all these have been responsible for forestry in the past. The results have been altogether disappointing; their primary duty and chief interest lay in other directions, and the matter might be aggravated in the future under the new development of agricultural policy. If the scheme of afforestation is to be successful, there must be a central authority, working out a consistent policy for the whole of the country, and allotting the areas to be afforested to those parts of it where the conditions are most favourable for success. In this respect, the widely varying systems of land tenure prevailing in the different parts of the country are of great importance. The comparatively modest cost of a new branch of the public service, the Sub-Committee felt sure, will be saved several times over in the long run. Further, the establishment of a separate administration will make the afforestation policy of the State as little as possible liable to be disturbed by political changes, although it must, of course, be subject to Parliamentary control. In the case of a single central authority, however, it will be most desirable that, in the actual execution of the work, it should closely co-operate with the Departments of Agriculture in the different parts of the country. The executive work should be, as far as possible, decentralised, and an organisation should be set up in each part of the kingdom, which will avail itself of local knowledge and experience.

18. Summary of Proposals.

Based on the above considerations, the Sub-Committee proposed the following scheme :—

(1) There should be set up a Forestry Commission consisting of six members, three of whom being whole-time salaried officials and the others unpaid, one of the latter being a M.P. to represent the Department in Parliament. The Forestry Commissioners should be given complete responsibility for carrying out the task which the Government may assign to them. A hope is expressed that three unpaid Commissioners will be found who are willing to

give to the scheme, at any rate during its critical early years, the value of their influence and experience. One of the Commissioners should be nominated Chairman, and at least one of those in receipt of a salary should be a technically trained Forest Officer.

(2) The chief executive officers of the Commission should be Assistant Commissioners; one of whom should be appointed for each of the parts of the United Kingdom which are independent units for agricultural administration. Their chief duty would be to carry out the policy of the Commission in close touch with the agricultural authorities.

(3) There should be Consultative Committees for England, Wales, Scotland, and Ireland, to assist the Commissioners in their work, containing representatives of the interests affected by the work of the Commission; on these Committees the Board of Agriculture should be represented.

(4) For the purpose of securing a certainty of steady and systematic development, a Forestry Fund should be created to cover the expenses during the first 10 years, upon which the Commissioners can draw as seems to be required by the progress of the work. An account of the expenditure of each year, and a forecast of that of the next year, should be placed before Parliament, and the work of the Commission would, of course, be subject to audit in the usual way.

(5) The powers and duties of the Commission should be defined. Powers must be taken to purchase and to lease land for afforestation and purposes connected therewith, to manage and develop any land so acquired, to dispose by sale or lease of land not suitable or not required for the purposes of the Commission, and generally to do all things incidental to the business of forestry. Various other powers now exercised by other departments, having reference to forestry, should be transferred to the Commission. It should be in a position to undertake, on behalf of the body concerned, the charge and management of the Crown forests and woods now under the

Office of Woods, and those under other departments. The duties of the Commission would be to carry out the scheme of afforestation here outlined, and to encourage and improve the management of existing woods; also the collection and preparation of statistics relating to forestry, the utilization of timber, the development of forest industries in general, the education of a competent staff, and the development of research on questions connected with forestry.

SECTION IV.—THE FORESTRY ACT, 1919, AND AFTER.

On the basis of the Sub-Committee's Report the Forestry Act of 1919 was passed. Its principal provisions are as follows:—

Clause 1 provides for the appointment by His Majesty of 8 Forestry Commissioners, of whom at least one shall be a person having scientific attainments and a technical knowledge of forestry. Not more than 3 of the Commissioners shall be paid a salary. One of the unpaid Commissioners shall be a member of the House of Parliament.

Clause 2. The Commissioners may, subject to the approval of the Treasury, appoint such officers and servants for the purposes of the Act as they think necessary, and may remove them.

Clause 3. The Commissioners shall be charged with the duty of promoting the interests of forestry, the development of afforestation, and the production and supply of timber in the United Kingdom. The Act also transfers to them certain powers exercised by other departments, both as regards forestry and the destruction of insects and other pests injurious to trees and timber. It empowers the Commissioners, subject to the directions of the Treasury:—

(*a*) To purchase or lease land for afforestation, manage, plant and otherwise use it, sell or let any land not required, or exchange such land for other land.

(*b*) To purchase and sell standing timber and promote the supply and utilization of timber generally.

(*c*) To assist financially persons and authorities in respect of afforestation or replanting.

(*d*) To undertake the management or supervision of woods belonging to private persons or corporations.

(*e*) To establish woodland industries or assist in establishing them.

(*f*) To collect, publish and distribute statistics relating to forestry, promote instruction in forestry, and conduct or assist research.

(*g*) To aid, or aid in making, enquiries for securing an adequate supply of timber in the United Kingdom, and to promote the production of timber in the Empire.

In this and the preceding clauses the expression "timber" includes all other forest produce.

Clause 4. Where trees or tree plants are being, or likely to be, damaged by rabbits, hares or vermin, the Commissioners may, after due notice, cause the rabbits, hares or vermin to be killed and taken, and recover from the occupier the net cost incurred by them. For this purpose vermin includes squirrels.

Clause 5. For the purpose of exercising the administrative powers and duties of the Commissioners, they shall appoint three officers to be Assistant Commissioners for England and Wales, Scotland and Ireland.

Clause 6 provides for the establishment of Consultative Committees for England, Scotland, Ireland and Wales, such Committees to include representatives of various bodies as well as persons having expert knowledge of forestry.

Clause 7 gives power for compulsory acquisition of land. Excepted lands are parks, demesnes, gardens, pleasure grounds, home farms, lands required for amenities, and a variety of other lands.

Clause 8 establishes a Forestry Fund of $3\frac{1}{2}$ million pounds and all receipts of the Commissioners, to meet the expenses of the first 10 years commencing on April 1st, 1919. It provides also for the rendering of an annual account to the Comptroller and Auditor-General, annual reports to Parliament, and control of the Fund by H.M. Treasury.

Clause 9 gives the Commissioners or their servants power to enter and survey land.

Clause 10 deals with the superannuation of the Commissioners and their staff.

The Forestry Commissioners were appointed on November 29th, 1919. Considerable progress has been made in the organisation of the Department. The purely executive work is in charge of the three Assistant Commissioners, with headquarters at London, Edinburgh and Dublin. Under the Assistant Commissioners are Divisional Officers, 5 for England and Wales, 4 for Scotland, and 2 for Ireland, each with a definite territorial charge. The Divisions in the aggregate cover the whole of Great Britain and Ireland. The Divisional Officer is an experienced forest officer and he is assisted by District Officers who will ultimately all be academically trained men. The Divisional Officer is responsible for all State forest work in his division, as well as for advice to private owners. The District Officers are his assistants for survey, reporting on land for acquisition, preparation of working plans, and similar technical matters. The supervision of planting operations, forest protection, and other routine work are placed in charge of Foresters.

The Commissioners reserve to themselves the general control of education, research and publication, but the executive work with regard to the foresters' schools and experimental work is attended to by the Assistant Commissioners. For the control of these subjects, there are attached to the headquarters of the Commission an Education and Publications Officer, an Experiment officer, an Entomologist, and a Co-ordination officer, the latter to secure co-ordination in technical procedure in the different parts of the United Kingdom.

The Commission meets once a month for the decision of matters of policy and to review progress. At these meetings the Assistant Commissioners usually attend, as well as such other officers as may be required. The Commissioners keep in touch with actual operations by frequent local inspections.

Finance is in charge of a Finance officer who is responsible to one of the Commissioners. The keeping of accounts for the individual estates is done by accountants, of whom one is attached to each divisional office. The estimated net expenditure for the financial year 1920—1921 was expected to be £379,000.

The general business of the Commission is done by the Secretary.

In collecting their technical staff, the Commission have been able to secure, on the one hand, the services of men who made a study of British forestry in pre-war time, and who were actively

engaged in timber supply work during the war, and, on the other hand, young men who had been trained at the Universities, but had not entered the profession owing to war service, or had been trained, when partially disabled, during the later stages of the war. In future it is proposed that men of the Forest Officer class shall be recruited from University trained men, and that Foresters shall be trained in the foresters' schools, which the Commission are running departmentally.

The Commission will publish an Annual Report. They have set to work with great vigour, and they are proceeding on the lines laid down in the Reconstruction Sub-Committee's Report. By June, 1920, they had secured some 60,000 acres of land and were negotiating for the acquisition of an additional area of 90,000 acres. Although no actual planting was proposed for the first year, a commencement was made by stocking during the winter of 1919—1920 an area of about 1,500 acres. The schemes of assistance to private proprietors and corporations are in the stage of discussion between the Commissioners and the Consultative Committees. Lectures to landowners, land agents and others interested in forestry have been started, while Divisional Officers are ready to advise private owners. On the whole, a very good beginning has been made to safeguard the country in the case of a future emergency.

When this book was prepared for the press, the first Annual Report of the Commissioners for the forest year ending September 30th, 1920, appeared. The acquired area amounts now to 103,100 acres, of which 68,100 acres are classed as plantable. The area actually planted had risen to 8,000 acres. With a view to assisting in giving work to unemployed, it has been arranged to speed up work by planting during the year 1921—1922 an area of 15,000 acres.

The work of the Commissioners in connection with the Imperial Forestry Conference has already been dealt with above.

C. FORESTRY IN BRITISH EAST INDIA.

SECTION I.—SHORT DESCRIPTION OF THE COUNTRY.

India is a very large country, extending from the 8th to the 37th degree northern latitude and from the 62nd to the 100th degree

eastern longitude. Its length north to south is about 2,000 miles, and its greatest breadth, including Burma, is about the same. The total area and population, according to the census of 1911, are as follows :—

	Area, Square Miles.	Population, Total.	Per Square Mile.
British Territory.	1,092,994	244,221,377	223
Indian States .	709,118	70,864,995	100
Total . .	1,802,112	315,086,372	175

It is beyond the scope of this book to give a detailed account of all the points on which the forest policy of India depends ; a few notes on the physical configuration of the country, its geology, soils and climate must suffice.

1. Configuration and Drainage.

Apart from Burma, India has, on the whole, a triangular shape with the Himalayas on the north, the Arabian Sea on the west, the Indian Ocean on the south, and the Bay of Bengal on the east. Burma lies to the east of the latter. India proper may be divided into three great sections : the Himalayas, the Indo-Gangetic plain and the Peninsula.

The Himalayan range stands out like a lofty wall on the north, separating India from the high plateau of Thibet. Commencing in the west, it runs first in a south-easterly and then in an easterly direction from one end of India to the other ; on the west and the east other ranges run almost due north and south. The space within these three ranges, immediately to the south of the Himalayas, forms a broad belt of low land, commencing in the west at Kurrachi on the Arabian Sea, including Sind, the Punjab plains, the greater part of Rajputana, the United Provinces, Behar and Lower Bengal down to the Sunderbuns beyond Calcutta on the Bay of Bengal. This belt of mostly alluvial land, not more than a few hundred feet above the level of the sea, is the richest part of India.

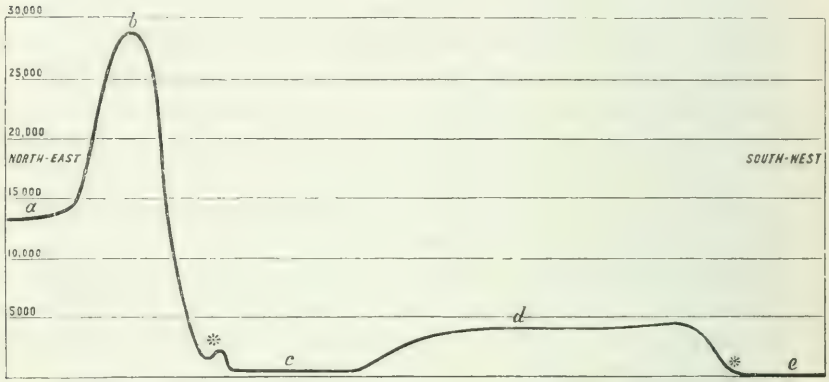
Proceeding across this belt of low land in a southerly direction stiff escarpments are met, indicating the commencement of the great highland plateau of the Indian Peninsula which, at elevations varying from 2,000 to 8,000 feet, extends to the southern

extremity of India at Cape Comorin. A section drawn from the Thibetan plateau in a south-westerly direction until it reaches the Indian Ocean at Travancore, would present the shape given in fig. 2, except that the elevations have been greatly exaggerated.

Fig. 3 gives an idea of the proportionate extent of each of the regions.

The river system of India next claims attention. It is a curious fact that India receives the drainage of both slopes

Fig. 2.



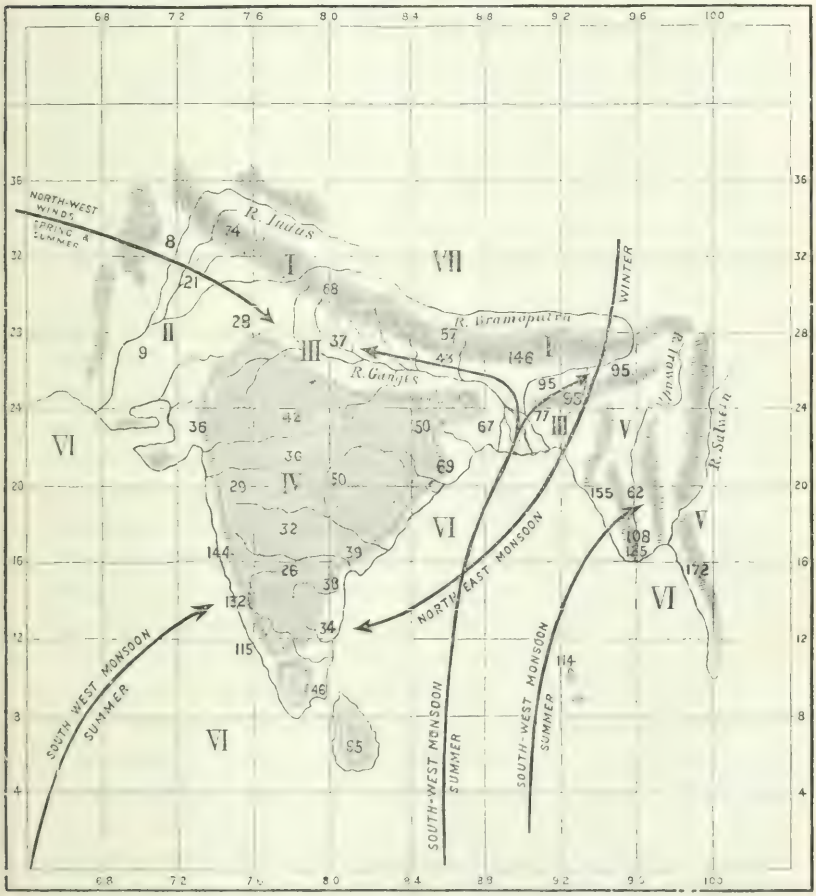
a. = Thibetan plateau, mean height about 14,000 feet.
b. = Himalayas, maximum height 29,000 feet.
c. = Indo-Gangetic plain, height a few hundred feet above the sea.
d. = Peninsula, height varying from 2,000 to 8,000 feet.
e. = The sea.
* = Points where the clouds coming from the sea must rise, cool, and drop their moisture.

of the Himalayas. At the back of that mountain chain three rivers take their rise in fairly close proximity to each other; one, the Sutlej, immediately breaks through the Himalayan chain and descends into the Punjab; the other two run parallel to the Himalayas, the one in a north-westerly and the other in an easterly direction. The former breaks, after some time, through the Himalayas and emerges into the Punjab plain as the River Indus, finding its way, through Sind, into the Arabian Sea. The latter of the two rivers, after running for hundreds of miles to the north of the Himalayas, also breaks through that mountain chain and appears in Upper Assam as the Bramaputra; it then proceeds

down the Assam valley, through Lower Bengal, and joins the Ganges shortly before reaching the Bay of Bengal.

The southern face of the Himalayas is drained, in its western

FIG. 3.



I. Himalayas.
II. Indus Plain.
III. Ganges Plain.
IV. Peninsula.
V. Burma.
VI. The Sea.
VII. Thibetan Plateau.
8, 9, 21. Mean Annual Rainfall, in inches.

part, by the Punjab rivers which join the Indus. East of Simla the Jumna and Ganges emerge from the hills, and join at Allahabad. The Ganges takes in a series of streams which drain the southern slopes of the range from the United Provinces to

Sikkim. To the east of this point the drainage goes into the Bramaputra. The drainage of the Peninsula is arranged in the following manner :—The Ganges receives the drainage of the northern edge. Next, two rivers, the Narbada and Tapti, run in close proximity in a western direction into the Arabian Sea. A series of short streams run from the Western Ghat to the sea, but by far the greater portion of the plateau sends its water in an eastern direction into the Bay of Bengal, because the highest part of the Peninsula is close to the sea on the west.

The two principal rivers in Burma are the Irawadi and the Salween. A third river, the Sittang, runs between the two. They run from north to south, but the Salween also takes in a large feeder, the Thaungyin, which comes from the south-east.

2. Geology and Soils.

The peninsula is one of the oldest formations on the earth and the Himalayas one of the most recent. The rising of the latter, apparently, caused the formation of the Indo-Gangetic plain, as well as that of the Assam valley. In the peninsula, crystalline schists, gneisses and plutonic rocks are common. These old formations have withstood folding, the features of the land being the result of differential erosion. In many parts they are covered by various systems known as the Gwaliors, Vindhians, Cuddapahs and Kurnools. The rocks of the last three are chiefly sandstones, shales and limestones. No marine fossils are found in them. At a later period these formations were covered over an area of 200,000 square miles in Bombay, the Central Provinces, Berar and Hyderabad by volcanic ashes and lava, in some places to a depth of 6,000 feet. These deposits are known as the Deccan trap.

The rest of India belongs to a later geological period; the rocks south of the Himalayan snowy range bear no fossils. When the Himalayas rose, the sea alternately receded from Upper India and Burma, and submerged again part of the country; hence fossiliferous rocks of marine origin are common, the oldest being the Salt Range in the Punjab. Quarzite, shales, slates, dolomite, limestone, conglomerate, granite and sandstones are among the rocks in the Himalayan north-west frontier, Assamese and Burmese regions, eruptive action being apparent in Baluchistan and Burma. Towards the foot of the Himalayas, no

evidence of marine action has been found, so that subsequent deposits must have been formed in fresh water. The Sivaliks running along the foot of the Himalayas are river deposits of sandstone, clay and conglomerates; similar formations of the same age occur in Assam and in Burma. The alluvial deposits in the plains of the Indus, Ganges and Brahmaputra are of recent origin; no boulders or pebbles are found in them. They consist chiefly of sandy, micaceous and calcareous clays. The older alluvium is distinguished by the nodular segregations of carbonate of lime known as "kankar."

It will be easily understood that the nature of the soil differs enormously. Those of alluvial origin are the most extensive, and their consistence ranges from loose drift sands to stiff clays. On the Deccan trap formation the soils are thin and poor on the higher levels, but the well known fertile black cotton soil predominates in the low lands. On the rest of the peninsular area the soils are derived chiefly from crystalline rocks; they vary very much in appearance, depth and fertility.

3. Climate.

Owing to the great extent of the country and the varying conditions prevailing in the several parts, it is not possible to speak of the climate of India; there are quite a series of climates, but they may be arranged into the following four main groups or types:—

(1) The climate of Tropical India.
(2) ,, ,, North-western India.
(3) ,, ,, North-eastern India.
(4) ,, ,, The Himalayas.

About one-half of the area of India, comprising the greater part of the Peninsula and Burma, is situated south of the tropic. These are the hottest parts of India as far as the average of the whole year is concerned; but the highest temperature is found further north. The arrival of the south-west monsoon mitigates the summer temperature in tropical India; on the other hand, this region enjoys little or no cool season, except at high elevation.

The second type of climate is found to the north of the tropic in the dry, and in some cases almost rainless, plain of the north-western part of India, comprising the area which is traversed by the river Indus and its feeders. Here the highest summer

temperature is found, due to a greater length of day and a later arrival of the monsoon rains than in tropical India ; this region receives to some extent compensation by 4 or 5 months of cool and even cold weather during winter, representing at that time a climate which has been compared with a south Italian summer.

The third type of climate is found in Assam and north-eastern Bengal. Here humidity of the air reigns supreme, although there is a distinct summer and winter : in either case the extremes of temperature are moderated by the effects of a relatively large amount of moisture in the atmosphere, which produces fogs in winter and interferes in summer with the full effect of the sun's rays on the land.

Finally, the Himalayan mountains present, according to the elevation and position of each locality, a more or less temperate and even Alpine climate with frost, snow, sleet and bitter winds in winter and a moderate heat in summer.

Between these four types, any number of intermediate climates are found. However large their number may be, and however much the various climates may differ, they are, apart from elevation, the result of a system of atmospheric changes, which are comparatively simple. The main-springs of the Indian climates are the following :—

(1) In spring and summer the extensive plains and table lands of India are heated to a much higher degree than the surrounding sea ; during winter the air overlying the sea is warmer than that over the land, from which at that season of the year heat freely radiates. The results are sea breezes during summer and land breezes during winter.

(2) The greater or smaller tendency with which moisture-laden air presses during spring and summer from the south towards India.

(3) The effect produced by the snowfall of the Himalayas on the movement of dry air currents coming from the north-west and penetrating into the Peninsula.

It will be useful to enter somewhat into the details of these phenomena. In spring, which shall here comprise the months of March, April and May, the highest temperature is found over the centre of the Peninsula (Nagpur, Hyderabad), while it falls as much as 5 to 10 degrees on proceeding towards the sea on the east and west, and about 10 degrees on proceeding to the foot of the

Himalayas or to the Punjab plain. The effect is that the air over the centre of the Peninsula expands, lifts the higher layers of air, causes them to flow away on all sides and produces a centre of comparatively low pressure. Into this centre presses the heavier atmosphere from the sea, causing the sea breezes so characteristic of the spring months.

These air currents deviate, however, from their original course in consequence of the law that everything moving over the northern hemisphere presses towards the right. The consequence is that the winds, which hit the Madras coast at this time of the year, are mostly south-easterly breezes, those which hit the southern half of the west coast come from the south-west, while those which hit the land to the north of Bombay become gradually more and more north-westerly winds. These phenomena have the result that Madras and the southern part of Bombay are passed over by moist sea winds which drop a portion of their moisture, producing during this period a rainfall of 3 to 6 inches. The above-mentioned north-westerly breezes, however, descend from the table land of Baluchistan ; they are dry and become more so in passing over the heated plains of Sind, Cutch and Kathiawar. These are the breezes which are known as the hot winds in the Bombay Presidency, in North-Western and Central India. At times they find their way as far as Bengal and Orissa and far down into the Peninsula.

Up to May the sea winds are light, and they bring only a moderate amount of rain, as the air is then drawn chiefly from the sea immediately surrounding the Peninsula. With the advancing season towards the end of May, the winds become stronger and stronger bringing more and more rain, until, in the course of three or four weeks, they have invaded the whole of the west coast of India and the northern and eastern coasts of the Bay of Bengal, an event which is known as the bursting of the monsoon. Now the winds are a northern continuation of the south-east trade winds coming from more distant equatorial regions, the great reservoir of moist air. Of late the theory has been advanced that the south-west monsoon is due to, or assisted by, a system of low pressure at the head of the Persian Gulf and a consequent indraft of the south-east trade winds. It seems to require further confirmation.

The strength of the monsoon rains differs greatly in different

parts of India ; it depends on the configuration of the country and the extent to which the sea breezes succeed in overcoming and pushing back the north-westerly dry air currents. The monsoon currents enter the Bay of Bengal from the south-west and they strike against the coast of Tenasserim in full force, rise and pour out a copious rainfall. This holds good in a varying degree along the coast of Burma, in Chittagong, Cachar and Assam. Along this line the rain clouds meet with hill ranges at moderate distances from the shore, which cause them to rise, cool, and drop their moisture, while the Lower Bengal plain receives a somewhat smaller rainfall. After passing through Lower Bengal and on approaching the Himalayan chain that mountain-range opposes itself to the course of the current and divides it into two parts. The larger part continues its north-easterly course and hits full on the Garo, Khasi and Naga hills, producing the highest rainfall in the world (over 400 inches at Cherrapunji), and finally giving a considerable rainfall to the Assam valley. The smaller part of the divided current is diverted towards the north-west and west, plentifully waters the face of the mountains and spreads a certain amount of rain over the plains of Behar and the United Provinces.

Lower Burma is plentifully watered, but a part of Upper Burma, on both banks of the Irawadi, receives but a scanty rainfall ; the latter increases again on approaching the hills in the northern part of Burma.

On the west coast of the Peninsula the monsoon blows directly athwart the coast line. As the western part of the Peninsula rises very rapidly from the sea to an elevation of up to 8,000 feet at the Ghat range, the clouds are forced to rise, cool and drop an enormous amount of rain. At the same time, the western edge of the peninsular plateau is its highest part, and the clouds, or what remains of them, having overcome this, descend again in their north-easterly progress ; hence, the rainfall diminishes rapidly on the eastern side of the Ghats to about one-sixth of that on the western slopes. This extends over a strip of 100 to 200 miles in breadth and comprises part of the Deccan, the Mysore table land and the Carnatic, areas which are much subject to drought.

Between the north-easterly course of the peninsular monsoon and the westerly course of the wind which, diverted by the Himalayas, moves up the Gangetic plain, lies a broad belt of

debatable ground, comprising part of the Central India States, the Satpura range, the greater part of the Central Provinces, the table land of Chutia Nagpur, Orissa and western Bengal. In this broad belt the rainfall is higher than to the south or north-west of it, chiefly because numerous storms, generated near the Bay of Bengal, travel along it from east to west, their passage being accompanied by heavy rain.

The country which lies to the north-west of this belt is under the effect of the western branch of the monsoon. Part of this passes through Gujarat, Rajputana, Cutch and Sind towards the Punjab, where it drops varying quantities of rain according to the configuration of the country. On the whole, however, the air current from the north-west becomes dryer, as it no longer comes from the ocean, but successively from Arabia, Persia, Baluchistan and Afghanistan ; hence, the rainfall decreases rapidly to the north of Bombay.

As long as the sea winds are sufficiently strong to keep in check, and even force back, the north-westerly winds during summer, all is well ; but every now and then the reverse is the case, that is to say, the north-west wind forces back the sea winds and proceeds further and further east and south-east into the United Provinces, Behar and even Bengal and Orissa, or it forces its way down into the Peninsula. If it keeps its sway over the sea winds for some period, a failure of the monsoon rains is the consequence, an event which is followed by scarcity or famine. It is believed that the strength of this dry air current from the north-west is intimately connected with the snowfall on the Himalayan ranges ; when that fall is heavy the north-west winds are strong and *vice versa*. Further observations seem, however, necessary to establish the absolute correctness of this view.

The copious watering of the surface of the land, in its turn, reduces the temperature, so that in some parts of the country the rainy season is actually the coolest time of the year. Indeed, this reduction is almost proportionate to the rainfall. Hence, districts which receive little rain, such as Sind, Western Rajputana parts of the Punjab, and also the Carnatic, show the highest temperature during summer. On the other hand, the temperature of Assam is comparatively little affected, because here rain falls copiously even in spring.

In September the monsoon commences to decline, but in Bengal, Assam and Burma the rains last well into October. In the beginning of the latter month the winds in the western part of the Bay of Bengal begin to blow from the north-east, and now for the first time the hitherto scantily watered Carnatic receives a copious rainfall : these rains go on until December, when they

Fig. 4.

gradually move southwards to Ceylon. They are followed by a dry, steady, north-east wind which gradually extends over the whole Bay of Bengal and is known as the north-east monsoon. An easterly wind at that period also takes possession of the Arabian Sea.

Meanwhile in Northern India the temperature, after a temporary slight rise on the cessation of the rains, has fallen rapidly during November and December, producing a cool air

and cloudless skies. About the end of the year, however, clouds begin to gather on mountain peaks, warmer breezes from the south set in, the skies become overcast, followed by a fall of rain, or snow on the hills. These winter rains are most frequent in the Punjab and the north-western Himalayas, but occasionally they extend also to Rajputana, Central India and Bengal. They become more frequent in January, February and March. And then a new round of seasons sets in.

It is not possible to give, in a limited space, an adequate idea of the endless differences in the climate and rainfall. By way of illustration, the table below is added in which a series of main groups have been formed. More detailed data must be looked for in the Reports of the Meteorological Reporter to the Government of India, from which the table has been compiled.

To illustrate further the distribution of the rainfall, a map of it is attached. The first of these maps was prepared by Sir Dietrich Brandis in 1872; it has been further elaborated by subsequent observations. The map now given is the latest edition of the Meteorological Department.

ABSTRACT SHOWING THE CLIMATE AND RAINFALL OF THE DIFFERENT PARTS OF INDIA.

Region.	Mean Annual Temperature in Degrees Fahrenheit.	Mean Annual Vapour Tension in inches.	Mean Annual Relative Humidity, in per cent. of Saturation.	Annual Rainfall in inches.
Himalayas . . .	58	·332	73	93
Indus Plain . . .	77	·483	47	21
West Gangetic Plain . .	78	·569	62	37
East Gangetic Plain and Assam	77	·748	80	77
Peninsula: Northern Edge .	74	·477	54	42
Peninsula: West Coast and Ghats	75	·700	79	132
Peninsula: Centre . .	80	·561	56	36
Peninsula: East Coast .	82	·738	67	38
Lower Burma . . .	79	·787	77	125
Bay Islands . . .	80	·871	81	114

SECTION II.—THE FORESTS OF INDIA.

1. Types of Forest.*

Owing to the great variety of climatic conditions in India and Burma, the flora is extremely varied, from full tropical development over more than half the area to intermediate conditions, desert and Alpine forest.

The types of forest depend chiefly on the rainfall, but also on the temperature, elevation above the sea, tidal and riparian positions. According to the heaviness of the rainfall the following four zones have been formed :—

The Wet zone with a rainfall of over 75 inches.
The Intermediate zone with a rainfall of 30 to 75 inches.
The Dry zone with a rainfall of 15 to 30 inches.
The Arid zone with a rainfall of less than 15 inches.

The wet zone is the home of the Evergreen forest ; the intermediate zone, of the Deciduous forest ; the dry zone, of the Dry forest ; and the arid zone is mostly treeless. Additional types are Hill and Alpine forests in the mountains, Tidal and Riparian forests.

(a) *The Evergreen Forests* are found chiefly on the west coast of the Peninsula, on the lower slopes of the eastern Himalayas, in Assam, Eastern Bengal, Chittagong, Burma and the Andaman Islands. The humidity and comparatively even temperature of these tropical and sub-tropical localities favour vigorous growth, so that some of the trees attain a height of 200 feet and a proportionate girth, but many of the trees are of small value.

On the west coast the rainfall is generally over 100 inches, the mean annual temperature 75 degrees, and the relative humidity close on 80 per cent. In the Assam valley the mean annual rainfall exceeds 75 inches, with 410 inches at Cherrapunji in the Khasia hills ; mean annual temperature 77 degrees, and humidity 80 per cent. In Burma the evergreen forests are chiefly found in the coast districts extending well into the valleys of the rivers. Lower Burma has a mean annual rainfall of 125 inches, a mean temperature of 79 degrees and a humidity of 77 per cent. On going north a much dryer area is met with, but on approaching the hilly parts of Upper Burma the rainfall increases again. Much of the Andaman Islands forest is evergreen, the climate resembling that of Lower Burma.

* For a detailed description, see Troup's "Silviculture of Indian Trees."

The number of species of trees found in the evergreen forest is very great. Some of these are found in all the three groups, such as *Calophyllum*, *Cinnamomum*, *Eugenia*, *Ficus*, *Garcinia*, *Mangifera*, *Mesua ferrea*, *Michelia*, *Cedrela Toona and Lagerstrœmia*. Others are found only in one or two of the three groups. Thus Assam has several species of *Quercus* and *Castanopsis*, also appearing in Upper Burma. The latter country is particularly rich in *Dipterocarps*. A little teak (*Tectona grandis*) appears in some of the evergreen forests on the west coast and in Burma.

(b) *The Deciduous Forests* occur over more than half the area of India ; they are the home of the most valuable species of trees. Of these, the following are conspicuous : *Tectona grandis* (Teak), *Shorea robusta* (Sal), *Chloroxylon Swietenia*, *Pterocarpus santalinus*, *Hardwickia binata*, *Albizzias*, *Xylia dolabriformis*, *Mimusops indica*, *Bassia latifolia*, *Dalbergias*, *Lagerstrœmias*, *Anogeissus latifolia*, *Terminalias*, *Dipterocarps*, *Bombax malabaricum*, *Butea frondosa*, *Acacia Catechu*, *Cedrela Toona*, *Schleichera trijuga*, *Buchanania latifolia*, *Careya arborea*, *Stephegyne parviflora*, *Adina cordifolia*, and many species of Bamboos.

Teak grows naturally throughout the Peninsula proper, south of the 26th degree of latitude, not on the east coast, but it extends into the evergreen forest of the west coast. In Burma it grows between the 16th and 26th degree, but not in the coast districts. In the Pegu Yomah it goes up to nearly 3,000 feet. Teak is rarely found in pure woods ; it is generally found mixed with many other species, of which the most valuable companion in Burma is *Xylia dolabriformis*. It has been estimated that the teak forests of Burma contain only about 10 per cent. of teak on an average. In India proper, it is usually accompanied by *Chloroxylon Swietenia*, *Dalbergia latifolia*, *Hardwickia binata*, *Ougenia dalbergioides*, *Pterocarpus Marsupium* and *santalinus*, *Santalum album*, and others.

Sal grows in two distinct tracts. The first of these is the submontane country from Kangra to lower Assam, ending in the Garo Hills. The second tract is situated south of the Ganges, comprising the Sonthal Pergunnahs, the Chutia Nagpore Division, Orissa, the Tributary Mehals, the northern part of Madras, and the eastern districts of the Central Provinces, with a solitary patch around Pachmari. The sal is gregarious, and the only place where it is found with teak is in the eastern part of the Central Provinces.

The sandalwood (*Santalum album*) is evergreen and occurs in the deciduous forests, chiefly in Mysore, Coorg, Bellary, Salem and Coimbatore in Southern India. The red sanders (*Pterocarpus santalinus*) is deciduous and grows in the dry hills of Cuddapah and North Arcot districts of Madras.

Certain species of *Dipterocarpus* (chiefly *D. tuberculatus*) form in Burma a type of forest called In or Eng forest, usually on laterite soils. They are accompanied by a limited number of other species such as *Dillenia pulcherrima*, *Shorea obtusa*, *Buchaniana latifolia*, *Diospyros birmanicus*, *Dalbergia cultrata*, *Xylia dolabriformis*, *Careya arborea* and *Pterocarpus indicus*. *Pterocarpus dalbergioides* (Padauk) is the most valuable tree of the Andamans, where it grows in deciduous and semi-evergreen forest.

(c) *The Dry Forest* occupies the plains of the Punjab, the western half of Rajputana and Sind as far as the rainfall suffices. Wherever that sinks below 15 inches, the tree growth becomes stunted and then disappears in the desert. In this region the highest and lowest shade temperatures (125 and 25) are recorded. The small trees develop enormously long roots, wherewith to reach the low-lying ground water. The principal trees found in this zone are *Bombax malabaricum*, *Butea frondosa*, *Acacias*, *Prosopis spicigera*, *Grewias*, *Capparis aphylla*, *Salvadora*, *Cordia*, *Anogeissus pendula*.

There is a second dry zone in the Peninsula to the east of the Ghats, comprising the Deccan, Mysore, and several Madras and Bombay districts ; but elevation above sea level produces local exceptions where the rainfall rises above 30 inches. The principal trees are *Prosopis*, *Capparis*, *Santalum album*, *Pterocarpus santalinus*, *Zizyphus*, *Acacia arabica*, *Albizzia amara* and others.

(d) *In the Arid Zone* are found *Acacia arabica*, *Prosopis*, *Capparis aphylla*, *Populus euphratica*, *Salvadora*, *Tamarix dioica* and *gallica*. Whenever the rainfall is much below 15 inches these trees show poor development or cannot live at all, unless the areas are artificially irrigated or occasionally inundated.

(e) *Hill Forests and Alpine Forests.*—The Himalayan forests differ not only according to elevation, but also according to position, due to the great difference of the climate. The hills of the North-west Frontier have a rainfall of about 15 inches ; in the Punjab hills it amounts to some 40 inches, and it increases in

going east, exceeding 100 inches in the eastern Himalayas. The relative humidity is generally high except in the north-west frontier districts. As a general rule, the rainfall decreases in the inner hills. In the North-west Frontier the chief trees are species of juniper. In the Punjab and United Provinces hills the following trees are the most important :—

Pinus longifolia between 2,000 to 5,000, and locally to 7,000 feet.

Cedrus Deodara between 4,000 and 10,000 feet.

Pinus excelsa between 4,000 and 11,000 feet.

Picea Morinda between 6,000 and 10,000 feet.

Abies Webbiana between 7,000 and 11,000 feet.

These conifers are generally associated with oaks, of which—

Quercus incana is found between 2,000 and 6,000 feet.

Quercus dilatata is found between 6,000 and 8,000 feet.

Quercus semecarpifolia is found between 8,000 and 11,000 feet.

Then follow *Betula Bhojpatra*, and *Juniperus Wallichiana* up to 14,000 feet. Other trees found in this zone are species of *Acer Æsculus*, *Buxus sempervirens*, *Juglans regia*, *Populus ciliata*, *Cypress* and *Yew*.

The above-mentioned trees generally reach perfection in the centre of their elevation, and they gradually fall off in vigour towards the upper limit of it. Spruce and silver fir are frequently mixed, but they are also gregarious, while *Quercus semecarpifolia* is nearly always so. *Pinus Gerardiana* is found in the inner hills to which little rain penetrates.

In the eastern Himalaya, in Sikkim, with its heavy rainfall, oaks, chestnuts, magnolias, laurels and tree rhododendrons are the prevailing species over 4,000 feet elevation ; above 9,000 feet they are replaced by numerous dwarf rhododendrons. *Pinus longifolia* is found in Sikkim at moderate elevations in valleys, and *Abies Webbiana* at high elevations up to 12,000 feet. In Bhutan, *Pinus excelsa* is found, also *Picea Morinda*. At high elevation in Sikkim *Tsuga Brunoniana* and *Larix Griffithii* are found. *Pinus Khasya* is found on the Assam hills.

In the Burma hills *Pinus Khasya* is found from the Assam frontier to the Southern Shan States at elevations of 2,000 to 7,000 feet, gregarious at the higher elevations, and often mixed with deciduous trees on lower elevations. *Pinus Merkusii* is

found between 500 and 1,500 feet, chiefly on the sandstone hills of the Thaungyin valley in Tenasserim, extending to the Shan States. The remaining hill forests of Burma resemble the oak and other forests of the eastern Himalaya.

(f) *The Tidal Forests* occupy alluvial land on the sea coast and in the estuaries of rivers, especially in the Sunderbuns, the Andamans and on the Burma coast. Mangrove forest grows on ground which is submerged at high tide ; it commonly consists of representatives of *Bruguiera, Ceriops, Kandelia, Rhizophora* and *Sonneratia.* Above high water-level are found *Casuarina equisetifolia, Erythrina indica, Excœcaria Agallocha, Heritiera Fomes, Pandanus tectorius,* and *Pongamia glabra.*

(g) *The Riparian Forests* can be treated as a type in so far as they are due to inundation or to percolation. They occur on swampy ground in Burma and Assam, where they are of comparatively little value. On the other hand, the forests of this type on the Indus and its tributaries are very valuable. Here the chief species are *Acacia arabica, Dalbergia Sissoo, Populus euphratica* and two species of *Tamarix.* Other trees, found in riparian forests in India, are *Acacia Catechu, Anogeissus acuminata, Bombax malabaricum, Eugenia, Ficus glomerata, Lagerstrœmia Flos Regina, Pongamia glabra, Salix, Terminalia Arjuna,* and *Vitex negundo.*

2. Area and Ownership of the Forests.

The following table gives the areas of forests arranged according to ownership, and those of other lands :—

Classes of Land.	Area in Square Miles.	Percentage of Land Area.
State forests, for Timber production	126,309	11·6
Other State forests . . .	125,159	11·5
Total State forests . .	251,468	23·1
Forests of Corporate Bodies . .	8,000	·7
Forests of Private Individuals .	77,000	7·1
Total of all forests . .	336,468	30·9
Agricultural Land . . .	431,896	39·5
Other land	322,430	29·6
Grand total of Land Area . .	1,090,794	100·0

The figures for Corporate and Private forests are estimates. The above data show that the forest area is equal to 30·9 per cent. of the total land area, which is about the same as the corresponding figure for the Forests of Europe. On the other hand, the forest area per head of population in India is ·9 of an acre, which is about one-half of what it is in Europe.

3. The Important Products of the Forests.

Owing to the great number of types of Indian forests, coupled with the diversity of climate, the number of species of timber trees is very large, and they are very unevenly distributed. While Sind has only 10 species of timber trees, Burma has about 2,500 with a similar number of other woody species.

Teak (*Tectona grandis*) takes first place, being the most important timber of India, if not of the whole earth. It yields the best timber for shipbuilding and is used for numerous other purposes. The tree reaches its highest perfection in Burma ; good teak is also produced in western and southern India. There is always a strong demand for teak even of small dimensions, such as is produced at its northern limit of distribution. The present annual output is approximately 260,000 tons, of which 225,000 tons are produced in Burma.

Sal (*Shorea robusta*) takes second place. It is a large gregarious tree, yielding a hard and very durable wood, which is used for building, bridge construction, piles, railway sleepers, and many other purposes. The total area of the State sal forests comprises approximately 6,700 square miles, and besides there are extensive sal forests in Nepal, estimated at 3,000 square miles. The annual output from the State forests is about 128,000 tons.

Deodar, also called " Himalayan cedar " (*Cedrus Deodara*), with blue pine (*Pinus excelsa*), chir pine (*Pinus longifolia*), silver fir (*Abies Webbiana*) and spruce (*Picea Morinda*), are the most important trees in the part of the Himalayas which is situated between the watershed of the Indus on the west, and the watershed of the Ganges on the east, comprising an area of 9,000 square miles of these forests. This tract yields some 280,000 tons of coniferous timber annually and is capable of yielding at least three times that quantity under systematic management working for a sustained yield. At present one-third of the area is under

State control, the rest being situated in Indian States. Deodar yields excellent timber, which is largely used for railway sleepers, building, carpentry and construction of all kinds. The utilization of the other conifers has, until lately, been very restricted, but it has rapidly increased of late. Their creosoting was attempted 45 years ago, but without success at that time, while improved methods have now made it possible. The *Pinus longifolia* is extensively tapped for resin.

Of the many species of Indian trees a large proportion have at present little or no value. Still the timber of several hundred species is used for some purpose or other, and their number is steadily increasing. Some of these timbers are of good quality, a fact which must be made known, but it would be beyond the scope of this book to enter into the details of the question.

Apart from timber and firewood, the Indian forests yield a great variety of other produce. Some of these have been utilized since time immemorial; others have been introduced with varying success since the establishment of forest conservation, others again, have only of late attracted attention. The following items may be mentioned by way of illustration :—

Bamboos, of which there are well over 100 species, big and small, are found over enormous areas ; many millions are cut for building materials for the people, and they promise to become one of the most important raw materials in the manufacture of paper.

Grasses of various kinds are utilized for paper making, but their chief use is for fodder and grazing. Many millions of cattle graze in the forests in ordinary years, and in times of scarcity enormous quantities of cut and pressed grass are transported to the threatened districts to keep especially the draft cattle alive.

Tanning materials exist in large quantities. *Terminalia Chebula* yields the myrabolan, of which large quantities were exported before the war. Some other sources are the young leaves of *Anogeissus latifolia* ; the fruit of *Zizyphus Xylopyrus*, the hill oaks, chestnuts and of *Sonneratia apetala ;* the leaves of *Heritiera minor*, of other mangrove trees and of *Nipa fruticans*. The bark of the following trees gives good tanning material : *Shorea robusta*, *Terminalia Arjuna*, *Woodfordia floribunda*, *Cassia auriculata* (almost exclusively used in the Peninsula) ; the pods of *Cæsalpinia digyna ;* the bark of *Acacia arabica* is

chiefly used in Northern India, as well as the pods; *Odina Wodier*, Cutch, the extract of the heartwood of *Acacia Catechu*, is used for tanning and as a dying material.

Essential oils are obtained from sandalwood (*Santalum album*), Eucalyptus oil from plantations established in the Nilgiris, the important Rosha oil from the grass *Cymbopogon Martini*; lemon grass oil from *Cymbopogon citratus*; *Saussurea Lappa* yields the valuable costus oil; *Gaultheria fragrantissima* yields "winter-green," as first found by Puran Singh, Chemical Adviser at the Forest Research Institute at Dehra Doon; from winter-green natural salicylic acid and natural sodium salicylate can easily be prepared.

Oleo-resins.—The pine tapped for its oleo-resin is *Pinus longifolia*, and the process has now developed into a big industry, the annual out-turn having of late been 2,400 tons of rosin and 156,000 gallons of turpentine. Only 100,000 acres have, so far, been tapped, so that the industry is capable of considerable extension. *Boswellia serrata* yields a gum-oleo-resin, which it is intended to take up shortly. The *Dipterocarps* of Burma yield the "wood-oil" of that province, used for the manufacture of torches, for oiling soap and caulking boats; it has been suggested as a solvent for caoutchouc. The oleo-resin derived from *Melanorrhœa usitata* is used in Burma for lacquer work; many enquiries have been received as to the development of the industry.

Gums are produced by a large number of Indian trees, but only a limited number give gums of commercial value. That obtained from *Acacia arabica*, the "babul" tree, resembles gum arabic; it is collected in large quantities in India.

An important astringent gum is obtained from *Pterocarpus Marsupium*, known as gum "kino." *Anogeissus latifolia*, the "dhaura" tree, gives a gum used extensively for sizing paper and in calico printing. The gum obtained from *Bauhinia retusa* is collected in considerable quantities in the outer Himalayas and used for medicinal purposes. The gum from *Odina Wodier* is used in fixing whitewash, sizing paper and in medicine. *Cochlospermum* gum is used by shoemakers, in medicine, and as a substitute for other gums. *Buchanania latifolia* yields large quantities of gum, which deserves further attention. The gums of *Gardenia lucida* and *gummifera* are used in cutaneous diseases.

India rubber is yielded by the indigenous *Ficus elastica*, a large evergreen tree found wild in moist forests of the outer Eastern Himalayas, Assam and Upper Burma. It has been artificially planted, but it cannot compete with the Para rubber tree. The Forest Department introduced the latter into India, and having proved the suitability of the climate of Tenasserim for the tree, sold the plantations to a private company. Since then further extensions have been made in South India, so that over 6,000 tons of rubber were exported from India in 1918—1919.

Drugs and Spices are collected from the forests, such as aconite belladonna, nux vomica, podophyllum, barberry, violet, wild pepper, cardamoms, pods of Cassia Fistula, tamarind and others.

Edible products are yielded by trees, shrubs and herbs, forming an important natural supply of food for the various jungle tribes, which is of considerable importance in time of scarcity. Special mention should be made of the flowers of *Bassia latifolia*, the " mohwa " tree, the corolla of which is eaten fresh or dried, or distilled into intoxicating liquor; recently they have been a source of supply of acetone and alcohol.

Animal products.—Lac, the production of *Tachardia lacca*, is one of the most important animal products of the forest, which is artificially propagated on a large scale. India has practically a monopoly of the lac industry, and its importance may be judged by the fact that the export of lac of various kinds in 1917—1918 was valued at 38 million rupees. *Silk* is another product capable of further development. Horns, hides, bones and ivory are other animal products.

It has been stated above that the percentage of land under forest in British India is about the same as that of the forests in Europe. There is, however, a great difference in the produce. While, at present, the European forests yield far more timber per unit of area than the Indian forests, the latter yield much greater quantities of valuable other so-called " minor produce." *

4. The Annual Increment of the Forests.

It is impossible to give any estimate of the increment of the corporation and private forests. And even as regards the State

* For further details see Troup's pamphlet " The Work of the Forest Department in India."

forests the necessary information is available only for those classified as set aside for timber productions. It is as follows :—

Area of Timber forests in square miles	126,309	
Increment per square mile	9,600	cubic ft.
Total Increment, rounded off	1,213,000,000	,, ,,
Loss by fire, waste, decay, &c.	36,000,000	,, ,,
Net Increment	1,177,000,000	,, ,,

5. Annual Exports and Imports of Timber.

The average annual exports and imports during the 5 years, 1914–1919, are given as follows :—

	Quantity, Cubic Feet.	Value £.
Imports :		
Railway sleeper wood	744,750	72,019
Deal and pine timber	816,150	141,079
Jarrah timber	181,800	18,793
Teak timber	1,079,700	219,351
Other timber	1,550,750	180,611
Total Imports	4,373,150	631,853
Exports :		
Teak timber	1,462,750	379,378
Other timber	185,100	16,517
Total Exports	1,647,850	395,895
Excess of Imports over Exports	2,725,300	235,958

6. Home Consumption of Timber.

A large proportion of the wood consumed in India comes from the private, and from what has been given above as " Other State Forests." No data are available regarding the quantities obtained from these sources. The material is mostly small, and the stocks in the private forests, at any rate, are somewhat rapidly diminishing.

It has been shown above that the increment of the 126,309

square miles of State timber forests is estimated, after the deduction of loss, at 1,177 million cubic feet. The quantities annually removed from these forests are given as 174 million cubic feet of timber and 173 million feet of firewood, making a total of 347 millions. This would represent less than one-third of the annual increment. In the past most of the timber was, however, taken from the best kinds, while the increment given above refers to the increment of all species. The amount of wood per head of population obtained annually from these forests comes to about $1\frac{1}{2}$ cubic feet, and the total consumption may be placed at about 3 cubic feet, as compared with 15 cubic feet in the United Kingdom. On the other hand, the people of India use enormous numbers of bamboos for construction.

Until quite lately, out of the thousands of species, only a small number were used as timber, which in many places have been overworked. At the same time the average increment per acre is estimated at 15 cubic feet, and this will increase in the same proportion as the management of the forests improves. The population is also increasing, but there can be no doubt that the Indian forests will continue to yield all the timber required by the people for a long time to come. At the same time the following measures are highly desirable :—

(1) Increased reproduction of the merchantable species ;
(2) Introduction of the better species at present unmarketable into the market, either in their natural state or after suitable treatment ;
(3) The opening out of forests at present inaccessible by the construction of roads and other means of transport.

SECTION III.—IMPORTANCE OF THE FORESTS TO THE NATION.

In former times certain forests were carefully protected as game preserves for the pleasure of kings, princes and great nobles. These areas were of small extent when compared with the area of the whole country. The idea of preserving forests for the supply of timber, fuel and other forest produce, or on account of their indirect effects on climate, rainfall, the regulation of moisture and the stability of the soil on sloping ground is of modern origin. It would lead too far to discuss the subject here

in all its details, but the main issues may be shortly mentioned. They are :—

Forest in relation to Climate and Rainfall.

The Regulation of Moisture.

Forest Produce required by the Country.

1. Forests in Relation to Climate and Rainfall.

This relation is of a very peculiar nature. On the one hand, a covering of forest vegetation reduces the temperature of the air and soil, increases the relative humidity and tends to increase precipitation. On the other hand, the exceptionally high temperature prevailing in spring and early summer over the centre of the peninsula is one of the agencies which bring about the summer monsoon rains. Thus afforestation might produce local precipitations, but it might also weaken the force of the south-west monsoon, or delay its arrival. Moreover, investigations instituted of late years by the Government of India, have shown that the effect of forests on the rainfall is so small, at any rate in the low lands, that it can be neglected ; it could not compensate for any interference which extensive afforestation might exercise upon the arrival of the south-west monsoon. As a matter of fact, three-fourths of the areas here under consideration is utilized for cultivation and grazing grounds. The south-west monsoon must, therefore, remain the main source of moisture in India. On the whole, the climate and rainfall of India are subject to influences compared with which the effect of a limited area of forests must always be very small. At the same time, the shade of forests and of trees generally will be gratefully accepted in a country as hot as India.

2. The Regulation of Moisture.

The regulation and husbanding of moisture in a country with an uncertain rainfall like India is of great importance as regards evaporation of moisture and the mechanical action of water.

The difference in evaporation between a forest-clad area and one exposed to the full effect of the sun and air currents is much greater in a tropical climate than it has been proved to be in a temperate climate. Hence, the presence of forest acts highly beneficial wherever the rainfall is limited, or unfavourably distri-

buted over the seasons of the year, or altogether uncertain, as is the case in many parts of India and also in some parts of Burma. In this respect the action of forests in India is highly beneficial.

3. Irrigation.

The beneficial action of forests upon the preservation of moisture becomes of special importance in countries like India where artificial irrigation is of national importance. In a primitive manner, irrigation has been carried out in India from time immemorial, but it was not done on a scale sufficient to prevent the horrors of periodic famines. One of the early measures taken by the British Government of India was to increase and systematise irrigation on lands in those parts of the country where the rainfall was not sufficient to secure the growth of food crops. Now, the existing irrigation systems have reached such an extent that starvation during periods of scarcity is no longer to be feared. Sufficient food for man and fodder for cattle can be sent by the existing railway systems in a comparatively short time.

The irrigation systems existing in 1914 are classified as follows :—

57 Productive Works irrigating .	16,320,500 acres.
30 Protective Works irrigating .	553,200 ,,
119 Minor Works irrigating. .	4,750,700 ,,
37,000 Tanks irrigating . .	3,275,200 ,,
Total	24,899,600 ,,
Add Areas irrigated from Wells .	10,000,000 ,,
Grand total of irrigated Area.	34,899,600 ,,

These areas are distributed over the several provinces of India, more particularly in the Punjab with 7·8 millions, Madras with 7·1 millions, Sind with 3·6 millions, United Provinces with 3·5 millions. The value of the crops produced on these areas amounts to 800,000,000 rupees (£80,000,000) annually.

Of the total irrigated area, about 10 million acres rely on water taken from rivers which are fed by the enormous snowfields of the Himalayas; the remaining areas derive their water, directly or indirectly, from the rain which falls on the heated surface of

moderately high hills and low lands. The larger the proportion of the catchment areas, whence this irrigation water comes, is shaded by forest growth, the more sustained will be the supply of water. Here then is a mission which forestry in India has to fulfil.

4. Mechanical Action of Forests.

The mechanical action of forest vegetation on sloping ground is not without importance in India. There is sufficient evidence to show what careless or injudicious clearing of forest may do. Anyone who has ever stood on the hills behind Hushiarpur in the Punjab and looked down upon the plain stretching out towards the south-west, has carried away an impression which he is not likely to forget. In that part the Siwalik range consists of an exceedingly friable rock. Formerly the range was covered with a growth of forest vegetation, but some time ago cattle owners settled in it, and under the combined attack of men, buffaloes, cows, sheep and goats, the natural growth disappeared, while the tread of the heavy beasts loosened the soil. The annual monsoon rains, though not heavy, commenced a process of erosion and of carrying away the surface soil. Gradually ravines and torrents were formed which have torn the hill range into the most fantastic shapes, while the debris has been carried into the plain, forming fan-shaped accumulations of sand reaching for miles into the plain, covering and rendering sterile extensive areas of formerly fertile fields. The evil will grow in extent unless curative measures are taken. Means of checking the mischief were considered for many years, and by 1896 the destruction had extended over an area of about 150 square miles. Grazing and wood cutting were then limited, and in 1913 steps were taken to deal systematically with afforestation in the affected areas. [See page 140.]

Although the case of the Hushiarpur Chos, as they are called, is the worst of its kind in India, there are other instances which prove that afforestation is essential on hill sides, wherever the rock is friable and likely to be dissolved and carried away by the continued action of water. It would, however, be a mistake to assume that every hillside requires to be under forest. This is not the case, wherever the rock is firm and capable of holding its own without the steadying help of a growth of forest vegetation.

Fig. 5.

The Hushiarpur Chos.

Showing the result of erosion on a sandstone formation.

5. Forest Produce required by the Country.

Although India has an extensive seaboard, along which forest produce can be landed, it does not derive as much benefit from this fact as might be assumed, because it is such a vast country. The distance between the sea shore and the place of consumption in the interior of the country amounts frequently to many hundreds of miles. Railways are as yet not as common as in England, and forest produce is, for the most part, bulky ; hence, only the coast districts would profit by the import of forest produce, even if it could be brought in sufficient quantities from other countries. As has been pointed out above, the imports in the past have been on a small scale, and these may be further reduced owing to increasing demands by other countries. There can be no doubt that India must rely on the timber and firewood produced in the country. There are considerable beds of coal in India, but they are inconveniently distributed over the country, and coal is at present used chiefly for industrial purposes and for export.

All the teeming millions of India use wood fuel for their firing, and, if this is not available, dried cow dung. Their using coal is out of the question for a long time to come, because the mass of the people have neither the necessary firing arrangements, nor could they afford to pay for the coal. For domestic firing India must maintain large areas under wood and an adequate area to provide for the annual requirements of timber for construction, boat building, tools, agricultural implements, public works and railways. And, judging by the standard which applies to continental countries of Europe, it may safely be estimated that India should permanently maintain a forest area of $\frac{1}{2}$ an acre per head of population, or, in round figures, 190,000 square miles in the British provinces, in order to secure a sufficient quantity of timber and firewood. That area would be equal to 18 per cent. of the total area of British India, or equal to about 75 per cent. of the area of the existing State forests.

It has been stated above that the estimated increment of the better half of the State forests is about 15 cubic feet per acre, while the consumption during the last few years has been about 3 cubic feet annually per head of population, so that less than $\frac{1}{2}$ an acre per head should suffice for all purposes. It should,

however, be remembered that the greater part of the increment is at present laid on by trees which are of little or no value, and that this process will continue until the proportion of valuable trees has been considerably increased, a process which will require something like a whole rotation. Besides, great demands are made on these forests for other produce, while the population is rapidly increasing. Moreover, there should now be a great development of forest industries and of export.

The Indian census of 1911 gave 1,191,367 people and their dependents employed on forest industries in British India, an estimate which was probably much below the actual. With the opening up of the forests, the extension of systematic working, the wider use of known products, and the discovery of new products, a steady development of industries dependent on the forests is sure to take place.

SECTION IV.—DEVELOPMENT OF INDIAN FOREST CONSERVANCY.

1. Historical.

If such evidence as is now available can be relied on, the greater part of India was in former times covered with forests. Subsequently, settlers opened out the country along fertile valleys and streams, but the destruction of the forests on a larger scale was done by nomadic tribes which, moving from pasture to pasture, fired alike hills and plains wherever they went. Many of these tribes consisted of Arians who had come across the Himalayas. This lasted for many centuries. With the advent of British rule, the destruction of the forests became more rapid than ever. The order of the day then became "extension of cultivation at the cost of the existing forests," a process which was carried on for many years without any enquiry as to the ultimate effects. To this was gradually added an increasing demand for timber, as well as for pasture for rapidly multiplying herds of cattle, which roamed far and wide through the forests. Shifting cultivation and fire did the rest. Then railways came, and with their extension the forests disappeared with greater rapidity than ever, partly on account of the increased demands for timber and firewood used in construction, and partly on account of the fresh impetus given to cultivation along the lines.

Ultimately, when failures to meet the demands for public works were brought to notice, it was recognised that a grievous mistake had been made in allowing the forests to be recklessly destroyed.

The question of forest conservancy in some parts of the country had already attracted attention in the very beginning of the nineteenth century, because difficulty had been experienced in providing the necessary timber for the Bombay dockyard and other works. A Government timber agency was established, but again abolished in 1823, in consequence of serious complaints having been made against it. In 1843 Mr. Conolly, Collector in Malabar, arose as a great advocate for the protection of the teak forests in that part of India, and he started a plantation which is now well known as the Nilambur teak plantation. Dr. Gibson was appointed Conservator of Forests in Bombay in 1847. Dr. Cleghorn commenced forest conservancy in Mysore in 1847, and he was appointed Conservator of Forests in Madras in 1856. These are some of the earlier pioneers of forest conservancy in Southern and Western India. In the meantime, in 1852, Pegu had been annexed, and the question of the Burma teak forests occupied the Government of the time. It was at this juncture that Lord Dalhousie, the great administrator, took up the matter and for the first time laid down a comprehensive forest policy. The steps which he took are indicated in paragraph 82 of his "Minute," dated February 28th, 1856, reviewing his administration in India from 1848 to 1856. One of his last measures in connection with forest administration in 1856 was the appointment of Dr. Brandis (afterwards Sir Dietrich Brandis) to the post of Superintendent of the Pegu forests. This officer, in his endeavour to preserve the fine Burma teak forests, carried on a determined struggle with the mercantile community of the province, whose object was to see the forests thrown open to private enterprise on the plea that the supply of teak was inexhaustible, and with the object of getting the greatest possible profit out of the forests in the shortest possible time. Lord Dalhousie having then left India, victory hung long in the balance, but with the help of Major Phayre (afterwards Sir Arthur Phayre), Dr. Brandis was ultimately victorious, and the greater part of the Burma teak forests was saved, forests which now yield an average annual net revenue of 15 million rupees.

In 1862 Dr. Brandis was called to Simla to advise Government on forest conservancy in other parts of India. At the outset he worked in conjunction with Dr. Cleghorn, and in 1864 he was appointed the first Inspector-General of Forests to the Government of India. From the year 1862 until 1883 he laboured steadily on the introduction of systematic forest management into the various parts of India.

2. Forest Legislation.

The first duty of the new Department was to ascertain the position and extent of the remaining forests, and more especially of the portion which was still the property of the State. During the long continued struggle between human action and the effort of self-preservation on the part of the forests, the latter succumbed wherever the climatic conditions were unfavourable ; hence, what remained of forests was situated in localities with a heavy rainfall, or where a scanty population had carried on a feeble warfare against the woodlands.

To enable the Forest Department to bring the forests under proper management and protection, a Forest Law was passed in 1865. This law empowered Government to declare certain areas to be " State Forests " but without interfering with the rights and privileges of the people. The claims of the latter were on such an excessive scale that real forest conservancy became practically impossible. The result was that a new Forest Act was passed in 1878, which, with certain subsequent modifications, is now in force. Its main provisions are the following :—

(1) Power to declare Government lands to be Reserved State Forests, after an enquiry into and settlement, or, if necessary, commutation of private or public rights in the area ; also power to prevent the springing up of any new rights.

(2) Power to declare any Government land a Protected forest ; in that case existing forest rights may be ascertained and recorded, but not definitely settled, nor is there any bar against the springing up of new rights.

(3) Power for the establishment of Village forests, to be managed for the benefit of village communities.

(4) Power to provide for the proper protection and management

of State forests, and for the protection of forest produce in transit.

(5) Power to provide for suitable punishment of offenders against the forest law and regulations made under it.

The Act is in force throughout India except in the following areas for which separate Acts or regulations have been passed: Madras, Burma, Assam, the North-west Frontier Province, British Baluchistan and Ajmer. These separate enactments, while conceived in the same spirit as that of the Indian Forest Act, of 1878, provide for local requirements.

3. The Indian Forest Policy Defined.

The general forest policy of the Government of India has been developed by degrees. In 1894, after great progress had been made in the organisation of the department, the Government of India issued a resolution, further augmented in 1904, laying down that the classification of the areas under the control of the Forest Department should be as follows:—

(*a*) Forests the preservation of which is essential on climatic and physical grounds.

(*b*) Forests which are managed chiefly for the supply of useful timber for commercial purposes and general construction.

(*c*) Minor forests which afford a supply of wood, fodder, grazing and other produce for local consumption, especially for the agricultural classes.

(*d*) Pasture lands, or grazing grounds, managed by the Forest Department.

It cannot be said that this resolution is happily worded, since it is practically impossible to separate the forests into the desired classes, as most of them serve several of the indicated purposes.

To class (*a*) belong the areas preserved for purposes of indirect utility, such as the effect of forests on climate, rainfall, water storage and the prevention of denudation. A special enquiry into the subject was conducted by the Government of India during the years 1907 to 1914, the results of which were (1) that the effect of forests on rainfall is probably very small, and (2) that denudation of the soil following the destruction of forests has been definitely established. Class (*b*) shall be managed chiefly for the production of the greatest possible quantity of useful timber for

commercial purposes, without, however, excluding the supply of the requirements of the surrounding population. Classes (*c*) and (*d*) contain the areas which are managed chiefly, or entirely, for the production of the forest produce necessary for the local population. In some parts of India these latter forests are the most important, inasmuch as the supply to the agricultural classes of the necessary produce is a paramount duty of the State, whenever the supply from private forests is not sufficient. The activity of the Indian forest department should not be judged from the revenue point of view only, but also, and frequently chiefly, by the degree of efficiency in supplying the population with the necessary forest produce. This is of special importance in a country like India, where frequent periods of scarcity, if not of famine, occur. At such times the classes (*c*) and (*d*) of forests are essential to the very existence of the people and their cattle. Unless the latter are in fair condition, the fields could not be ploughed for the next food crop. Even in ordinary years very large quantities of produce are given free of charge from the State forests or at reduced prices, whenever necessary, so as to assist the local cultivator.

It has been stated above that in many parts of India dried cow dung is used as fuel, and thus taken away from its legitimate use as manure. In the year 1873 the author of this book suggested the formation of fuel reserves in the Province of Behar, so that cow dung should be used for manure. No action was taken on this suggestion, but, some 20 years later, Dr. Voelker, the agricultural expert, brought the matter forward as one of great importance in the improvement of agriculture. Then more attention was paid to the establishment of fuel and fodder reserves by means of afforestation, wherever the existing forests were not sufficient to yield the necessary quantities.

4. Organisation, Administration and Staff.

As already mentioned, the organised Indian Forest Department dates from the year 1864. The forest administration is placed under the Local Governments, which in future will be presided over by Governors in Council. Their action is, however, controlled by the Government of India. What shape that control will take in the future is as yet somewhat uncertain, as great

changes in the government of the country are taking place at this moment. Hitherto the control of the Government of India over the provincial Governments in forest matters was exercised chiefly as regards general forest policy, financial matters, the appointment of the head forest officers, the provisions of the forest law and of the Civil Service Regulations and the Civil Accounts Code.

The forestry business of the Government of India is dealt with in the Department of Revenue and Agriculture. The Inspector-General of Forests is the Chief Adviser to the Government of India, and, as such, the Head of the Forest Department. Local Governments also may obtain his views on the management of the forests in their Provinces. The Inspector-General may correspond direct with the local heads of the service on professional matters, when he requires information or desires to make suggestions, but copies of any important letters are communicated to the Government of India and the Local Government. He keeps himself informed of the progress of the work by tours through the forests during a considerable part of the year. He is also consulted in the preparation of Forest Working Plans.

Until comparatively recent years, each Province had one Conservator of Forests, who administered the forest business under the control, and on behalf, of the Local Government. Owing to the increase of the work, the larger Provinces have been divided into several Conservatorships, or Circles, with a Chief Conservator for the Province. The Chief Conservators or Conservators, as the case may be, are the immediate advisers of the Local Governments. Each Circle is divided into the following charges :—

(*a*) Divisions, or Controlling Charges.
(*b*) Each Division into Ranges, or Executive Charges.
(*c*) Each Range into Beats, or Protective Charges.

The Forest Service, or Staff, comprises three branches :—

(1) The Imperial Service, consisting at present of :—

Inspector-General of Forests . . .	1	
Chief Conservators of Forests . . .	6	
Conservators of Forests	25	
Deputy and Assistant Conservators of Forests.	225	
Total Imperial Service		257

(2) The Provincial Service, consisting of :—		
Extra Deputy Conservators of Forests .	58	
Extra Assistant Conservators of Forests .	202	
Total Provincial Service . .		260
(3) The Subordinate Service, consisting of :—		
Forest Rangers	840	
Deputy Rangers and Foresters . . .	2,900	
Forest Guards	11,500	
Total Subordinate Service . . .		15,240
Grand total, cadres. . . .		15,757

The posts of Inspector-General, Chief Conservators, Conservators, and the more important Divisions are held by members of the Imperial Forest Service. Some of the Divisions, generally the less important, are held by members of the Provincial Service. Ranges are held by Forest Rangers, who in many cases are assisted by Deputy Rangers and Foresters. Guards hold charge of Beats.

Apart from the territorial charges mentioned above, there are a number of non-territorial charges, or special posts, connected with the preparation of forest working plans, research, education and other special duties. Most of these charges are held by members of the Imperial and Provincial Services enumerated above ; others are held by Specialists.

5. Recruitment and Education.

When the Forest Department was started in 1864 it contained no specially trained forest officer. Up to that time the leading foresters were mostly military officers, including several medical men. They did excellent work during the early introduction of forest conservancy and for a series of years afterwards. Sir Dietrich Brandis, the first Inspector-General, considered it very important that early steps should be taken to secure a staff of specially trained officers, and under his advice it was arranged to train a number of young Englishmen on the Continent of Europe. This was in 1866. In the same year two highly trained forest officers were obtained from Germany to assist in the immediate develop-

ment of the department. The latter joined at once in India, and the students were sent, half to Germany and the other half to France, for instruction in forestry. Subsequently, in 1875, the English forestry students were concentrated at Nancy. Ten years later, in 1885, matters were considered ripe for starting a school of forestry in England in connection with the Coopers Hill Engineering College. The task was entrusted to the author of this book, who organised and presided over this, the first School of Forestry in the United Kingdom, during 20 years. When Coopers Hill College was closed, the forest branch was, in 1905, transferred to the University of Oxford, of which it has been a branch until the present time. The number of Indian Forest officers educated under these arrangements up to 1914 was as follows:—

Educated in France . . .	72
Educated in Germany . . .	25
Educated at Coopers Hill . .	153
Educated at Oxford . . .	95
Total	345

Of the officers trained on the Continent, only 3 remained at the end of 1914, and 4 were trained at Cambridge. Hence, out of an Imperial Staff of 230 in 1914 as many as 223 were educated by the author of this book.

In consequence of action on the part of the Universities of Cambridge and Edinburgh, the Secretary of State for India, in 1911, threw open the education of the probationers for the Indian Forest Service to any British University which satisfied him as having a course of instruction in forestry of a standard sufficient for the requirements of the Indian Government. Since then 7 officers from Cambridge and 5 from Edinburgh had joined by the end of 1919.

Owing to the war practically no recruiting took place between 1914 and 1918. Since then about 80 demobilised Officers have been appointed Probationers for the Indian Imperial Forest Service. Of these some are now on their way to India.

Owing to the great changes lately introduced into the system of Indian Government, the method of training the future members

of the Imperial Forest Service is once more under consideration, and it is impossible to foresee what further changes will be introduced.

The Provincial Service members are recruited in India and trained in connection with the Forest Research Institute, Dehra Dun ; a certain number of posts in the service are, however, filled by the promotion of specially promising Rangers. The teaching is supplemented by practical instruction in various parts of India.

The adequate instruction of the Subordinate Service was first suggested by the author in 1873, when he was Conservator in Bengal. Sir Dietrich Brandis was then on leave in Europe, and after his return to India in 1874, he took up the subject, and practical training was commenced at Dehra Dun in 1875. A complete course of instruction had been established by 1878. It is the oldest School of Forestry in the British Empire. The instruction extended to Rangers and Foresters. Since then schools for Rangers have been established at Pyinmana in Burma, at Coimbatore in Madras, and at Dharwar in Bombay. Other similar schools for Rangers are proposed. The training of subordinates below the rank of Ranger has been provincialised. There are now elementary forest schools in Madras, Bombay, Bengal with Behar and Orissa, the United Provinces, Punjab with the North-west Frontier Province, Burma, Central Provinces and Assam.

SECTION V.—PROGRESS OF FOREST ADMINISTRATION.

1. Establishment of Permanent State Forests.

When the Forest Department was organised in 1864 the first duty of the comparatively small staff consisted in ascertaining the position, extent, and general character of the forests, while at the same time organising a system of protection and exploitation according to the condition of the several areas. Many of the forests were more or less ruined by the careless exploitation of the valuable species and by the ravages of forest fires. In drawing up preliminary working schemes, the principle of a *sustained yield* was recognised from the outset. This, however, caused a good deal of friction between the forester and the timber dealer. The former insisted on not only maintaining the present yield capacity, but also on increasing it in the future, while the timber dealer declared the supply of timber to be inexhaustible, a view which was in many cases supported by the civil authorities. The

struggle between the contending parties was long, but ultimately sound views obtained the upper hand, and then more rapid progress became possible. The area placed under the administration of the Forest Department increased until it reached the present area of 251,000 square miles.

As soon as the Indian Forest Act of 1878 had been passed, the Department set to work to establish a sufficient area of permanent State forests, called " Reserved Forests " in the Act. As reservation has to be preceded by a forest settlement and accompanied by the demarcation of the boundaries of the reserves, it represents an immense amount of work, which even now has not yet been concluded, as the following data will show. It has been stated above that to meet the future requirements of forest produce, an area of 190,000 square miles of permanent State forests, equal to 18 per cent. of the total area, should be established. The progress made in that direction up to 1914 is shown in the subjoined statement :—

TABLE SHOWING THE PROGRESS MADE UP TO 1914 IN THE SELECTION OF PERMANENT STATE FORESTS.

Province.	Total Area Square Miles.	Forest Area in Square Miles.				Percentage of Forest to Total Area of Province.
		Reserved.	Protected.	Unclassed.	Total.	
1. Madras	142,402	18,863	—	802	19,665	13·8
2. Bombay and Sind	123,316	11,857	385	—	12,242	9·9
3. Bengal	78,875	4,871	1,711	4,030	10,612	13·5
4. United Provinces	106,773	4,121	33	39	4,193	3·9
5. Punjab	96,650	2,165	5,203	946	8,314	8·6
6. Burma	224,854	27,332	—	114,111	141,443	62·9
7. Behar and Orissa	83,073	1,727	1,058	—	2,785	3·4
8. Assam	48,915	4,381	—	18,401	22,782	46·6
9. Central Province and Behar	99,876	19,684	—	—	19,684	19·7
10. Coorg	1,582	520	—	—	520	32·9
11. N.-W. Frontier Province	13,184	236	—	—	236	1·8
12. Ajmer	2,767	142	—	—	142	5·1
13. Baluchistan	54,228	313	—	472	785	1·4
14. Andamans and Nicobars	3,143	85	—	2,124	2,209	70·3
Total in 1914	1,079,638	96,297	8,390	140,925	245,612	22·7
Total in 1920	1,080,814	103,003	7,941	140,005	250,949	23·2

It will be observed that the area of forests under the control of the Forest Department is about one-fourth of the total area of British India. The percentage of the Reserved, or Permanent, State Forests, is only 10 per cent. of the total area of the British part of India ; it should, by degrees, be raised so as to come nearer the area required to supply India permanently with the necessary forest produce, that area having been estimated at 18 per cent. of the total area of the country. There are extensive private and village forests which yield a considerable amount of grazing, fuel and small timber, but they have been much reduced in yield capacity, a process which is still going on, so that the people are coming more and more for produce to the State forests. Still, the private and village forests will continue giving a certain yield, so that not the full 18 per cent., or 190,000 square miles, need be converted into permanent State forests. It will probably suffice if their area is gradually brought up to, say, 150,000 square miles, leaving about 100,000 square miles available for further extension of cultivation, village grazing grounds and other purposes. Unfortunately, the percentage differs very much, and it is especially small in those provinces where an extension is most wanted. While Burma and Assam have as yet more forests than they permanently require, Behar, the United Provinces, the Punjab and some other provinces have too little. In most of the latter provinces areas are urgently required for fuel reserves, so that the cow dung, which is now burnt, may be made available for manure.

A most important work is the settlement of rights in the permanent State forests. This is done in connection with the reservation proceedings by specially appointed Settlement Officers. Up to the year 1914 the settlement extended over 101,585 square miles of reserves, or proposed reserves, and 6,414 square miles of protected forests. The demarcation of boundaries extended over a length of 165,051 miles, keeping pace with reservation.

2. Forest Survey.

As sufficiently detailed maps are essential for systematic management, a special Forest Survey Department was organised in 1871 and subsequently amalgamated with the general Indian Survey Department. Up to 1920 a forest area of 87,001 square

miles had been surveyed and mapped, mostly on a scale of 4 inches to the mile.

3. Forest Working Plans.

The management of Forests depends on the objects which the proprietor has in view ; they may be of direct or indirect utility as explained in Part I. of this book. All forests, to do justice to the object for which they are maintained, must be managed in accordance with well considered working plans, or schemes, drawn up on scientific and economic lines, so as to secure continuity of action and the best possible results. In some cases they may be of a simple nature, but for regular timber forests the plans must be of a more complicated description.

The advisability of a systematic working of the Indian forests for a sustained yield was recognised during the early days of forest administration in India, and a start of drawing up working plans was made in 1856, when Sir D. Brandis commenced preparing so-called " preliminary working plans " for the Burma teak forests. These plans were naturally drawn up on general lines, but on conservative principles to guard against overworking. When Brandis became Inspector-General of Forests he introduced the same system into other provinces. All his working plans aimed at a sustained yield. Their preparation devolved to a great extent upon himself, until the arrival of efficiently trained Assistants to help him. Subsequently it became difficult to prevent the working of the forests in excess of their permanent yield capacity, and, on the proposal of the author, the Government of India, with the approval of the Secretary of State for India, established in 1884 the " *Working Plan Branch* " under the direction of the Inspector-General of Forests. The preparation of the plans continued to be carried out by local agency and under the control of the Local Government and the technical advice of the Inspector-General of Forests. A plan once approved cannot be departed from without the previous sanction of Government. This step has been described as one of the epoch-making events in the history of Indian forest management. It sanctified the principle of a sustained yield of the forests, and it afforded the means of bringing together statistical data bearing on the future management and improvement of the forests. The preparation of working plans requires a competent staff and involves much

labour. Under the Regulation of 1884 and subsequent amendments, progress has been so satisfactory that by 1914 plans had been sanctioned for an area of 53,926 square miles, distributed as follows :—

	Square Miles.
Madras	8,091
Bombay	6,765
Bengal	4,965
United Provinces	4,077
Punjab	3,969
Burma	7,933
Behar and Orissa	1,460
Assam	1,134
Central Provinces	14,632
Coorg	207
N.W. Frontier Province	236
Ajmer	140
Andaman Islands	317
Total, 1914	53,926
Total, 1920	59,520
Under preparation	8,704
Grand total	68,224

The most important forests were taken in hand first. It is estimated that in the immediate future plans are required for an additional area of 20,663 square miles. For some of the remaining areas plans are not required at present, but, as time goes on, working plans will, no doubt, ultimately be necessary for all forests.

Instructions, defining the manner in which working plans shall be drawn up, are given in the Indian Forest Code. They give sufficient latitude to allow for local conditions, and are divided into Part I. Summary of Facts as the Basis of Proposals, and Part II. Future Management discussed and prescribed. When it is proposed to draw up a working plan, a short preliminary report is prepared setting forth the lines on which it is proposed to proceed. This report is submitted to the Inspector-General for an expression of his opinion, which he sends to the local Government. When the working plan is ready, a copy is forwarded to the Inspector-General, who may further criticise it or accept it. Then the local Government issues the necessary

orders to the local Conservator for carrying out the provisions of the plan, with such modifications as it may deem desirable. If any difference of opinion between the Local Government and the Inspector-General cannot be amicably arranged, the Government of India passes final orders on it.

4. Methods of Treatment.

The original system of managing high forest in India is that of *Selection Fellings*. The forests are gone over periodically, mature trees removed and so-called improvement cuttings added, that is to say, unmarketable species, which interfere with the valuable kinds, are girdled or cut down. The result is that the annual work is scattered over very large areas, and in the majority of cases results were anything but satisfactory. As early as 1868, the author proposed *more concentrated working* of the Burmese teak forests, but the proposal was at that time rejected. When the author held the position of Inspector-General of Forests he selected the Tano forests in the Dehra Dun for a trial of concentrated working according to the system known as the "Uniform or Compartment System." Later on the adoption of more rational systems, based upon the silvicultural requirements of the species and of their regeneration, found more favour, and quite recently the subject has been vigorously taken up by the late Inspector-General, Mr. Hart, and especially by the Assistant Inspector-General, Mr. Troup (both former pupils of the author). This, it may safely be said, is likely to become another epoch-making step in the management of the Indian forests. The improved systems are being introduced cautiously, and the areas treated under them are as yet small, as the following data will show :—

	Square Miles.
System of Clear Felling	263
The Uniform Compartment System	552
The Group System	95
Selection Method with Improvement Fellings	15,914
Simple Coppice	1,009
Coppice with Standards	7,060
Method of Improvement Cutting only	12,254
Unallotted	15,955
Total	53,102

These data do not include the forests of Madras and Bombay which are worked under the provisions of working plans. The most important point in the selection of the system is, apart from local conditions, to secure an adequate amount of regeneration of the valuable species. By far the greater part of the Indian forests is regenerated by natural means, that is to say, by young growth springing up from seed falling from the old crop, assisted by cuttings so regulated that regeneration takes place within a reasonable period of time.

5. Sowing and Planting.

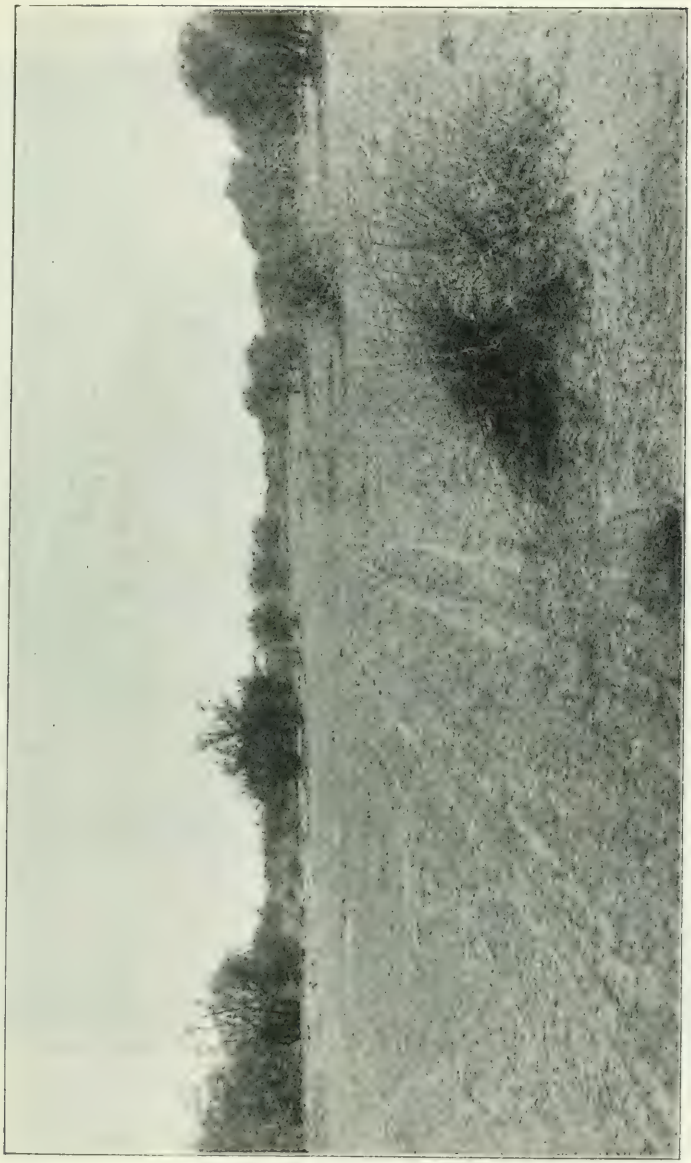
Artificial regeneration by sowing and planting is not excluded. It has to assist natural regeneration where that fails, and it is the only means in the case of afforestation, as well as in the system of clear felling in high forests. The following statement gives the area of plantations in 1914, in acres :—

Province.	Regular Plantations.	Taungya Plantations.	Total.
Madras . .	27,544 ..	2,905 ..	30,449
Bombay . .	7,808 ..	— ..	7,808
Bengal . .	1,267 ..	225 ..	1,492
United Provinces.	6,470 ..	— ..	6,470
Punjab . .	1,115 ..	— ..	1,115
Burma . .	3,361 ..	76,142 ..	79,503
Behar and Orissa.	909 ..	— ..	909
Assam . .	3,316 ..	51 ..	3,367
Central Provinces.	647 ..	6,328 ..	6,975
Coorg. . .	2,072 ..	2,179 ..	4,251
Ajmer . .	182 ..	— ..	182
Baluchistan .	46 ..	— ..	46
Andamans . .	1,018 ..	— ..	1,018
Total .	55,755 ..	87,830 ..	143,585

By 1920 the total area had risen to 168,000 acres.

This statement does not, however, include old plantations which have passed into the condition of forests, such as the Changa Manga plantation in the Punjab, with an area of 11,000 acres. It was started in 1868 and is so successful that it yields now 8 per cent. on the invested capital. The plantation was made on

Fig. 6.



The Changa Manga Plantation, showing the nature of the land before planting.
Rainfall, under 15 inches. In the distance a sprinkling of *Prosopis spicigera*, *Salvadora* and *Capparis aphylla*.

Fig. 7.

The Changa Manga Plantation, 17 years after planting commenced.
(From a photograph by the late Mr. D'Arcy.)

practically desert land by irrigation with the surplus water of the Bari-Duab canal. The appended illustrations show the land in its natural condition and 17 years after the planting. The best known instance of successful planting is the Nillambor teak plantation in Madras now up to 75 years old ; it gives a handsome return.

The most important class of plantations are the taungya (hill garden) plantations of teak in Burma. It is a combination of the rearing of field crops with the sowing (or planting) of teak seed. By establishing them on selected concentrated areas, the production of teak in the future will be a multiple of what it is now, especially as marketable mature trees will be produced in a much shorter time than in the existing natural forests. As the regeneration of Bengal Sal forests by natural means has met with great difficulty, the system of clear-cutting followed by planting has lately been recommended in the Duars forests, the idea having been based chiefly on the results of a Sal plantation made by the author in the year 1875 in the Buxa reserve.

6. Afforestation of New Areas.

It has been explained above that the percentage of State forests is small and not sufficient to provide permanently for the requirements of several provinces. This remark refers to the United Provinces, the Punjab, Bengal, Behar, the North-western Provinces, Ajmer and Baluchistan. In some of these provinces fuel reserves are specially wanted, so that the cow dung, which is now burnt, may be made available for manure. The matter was considered in 1882 as regards the establishment of fuel and fodder reserves in the United Provinces. Thirty years later the Government of the latter provinces announced, in 1912, a definite policy of afforestation of ravine lands and the formation of fuel and fodder reserves in the dry tracts of the plains. To give effect to this policy, an afforestation division has been established. A systematic survey of waste lands has been started in Jhansi, Hamirpur, Jalaun and Etawah districts, and the work of reclamation and afforestation has been taken in hand.

In the Punjab, plantations in the rakh districts were started 52 years ago. Numerous plantations were established especially along the railway lines, including that at Changa Manga already

mentioned. It is now proposed to add 50,000 acres in connection with the irrigation projects of the Doab. Measures like these, which affect so closely the well-being of the agricultural population, should have far-reaching results, and it is hoped that similar works will soon be undertaken in other provinces.

7. Protection against Fire.

Before the author started for India in 1866, Sir Dietrich Brandis told him that the Indian forests could be divided into the following two classes :—

(1) Forests which were burnt every year, and

(2) Forests which were not burnt every year.

As a matter of fact, by far the greater part of the forests were annually overrun by surface fires, which burnt the undergrowth, including the seedlings of trees, and injured, more or less, the older trees. Thus, they interfered, in the majority of cases, with regeneration and caused disease in trees, though the latter may not become apparent until many years afterwards.

As early as 1846 Lieutenant (afterwards General) Michael tried to stop forest fires in the Anamalay hills in Madras, but the first really successful attempt was made by Colonel Pearson in the Bori reserve in the Central Provinces about the year 1860. Since then the area artificially protected has risen to 49,970 square miles. Of this area 5·4 per cent. on an average were burnt annually. Fire protecting measures consist chiefly in maintaining cleared external and internal lines, organising an efficient system of patrols, enlisting the co-operation of the local population, burning inflammable grass lands early in the season and extinguishing any fires which may break out.

In by far the majority of cases the forests have greatly benefited, and there can be no doubt that in most types of forest the improvement which has taken place in the growing stock is due mainly to the effect of fire protection. At the same time it must be admitted that in certain cases fire protection has interfered with the natural regeneration of the forests, as the encouragement given to the growth of evergreen shrubs and strong weeds has wholly or partially prevented the springing up or the survival of seedlings of the valuable species. This result has been observed in the moister types of teak forest in Burma, and also in the sal

forests of the Bengal and Assam Duars. The measures to be taken in such cases are now under consideration in connection with the more concentrated working of the teak forests, and of the sal forests in the Duars.

8. Grazing and Grass Operations.

Forestry in India is closely connected with grazing; its intensity varies much in different localities. It is essential, on the one hand, that liberal arrangements are made for the necessary village grazing, and, on the other hand, that the valuable forests are protected against damage by grazing animals. Above all, browsers, such as camels, goats and sheep, must be excluded from important forests, if not permanently, at any rate at times when regeneration is expected. Accordingly, certain areas are closed against grazing, while others are opened for it. In 1914 the following classification existed :—

	Square Miles.
Areas closed to all animals, whole year. .	43,591
Areas closed to all animals, part of year .	6,699
Areas closed to browsers only, whole year .	23,302
Areas closed to browsers only, part of year .	436
Area open to all animals	175,336
Total	249,364

These data show that 30 per cent. of the total area were closed in various ways, and 70 per cent. were open to grazing.

In times of famine or fodder scarcity, grass operations form an important part of the work of the Forest Department, especially in Bombay, the Central Provinces, the United Provinces, and Madras. At such times, not only are closed areas thrown open to grazing, but large quantities of grass are pressed into bales and sent to the affected districts.

9. Communications and Buildings.

The successful management and working of the forests depends largely upon the extent to which facilities for inspection and for extraction of the produce are provided. Hence, it is necessary

to construct inspection paths, roads, slides, tramways, ropeways and other mechanical compliances, according to local requirements ; in many cases streams must be made fit for floating and rafting. The latter operations were commenced in Burma more than 60 years ago, when an Inspector and a working party blasted rocks in streams throughout the dry season, year after year.

Generally, the Department has been very active in constructing means of communication, as far as the means at its disposal permitted. The use of mechanical transport in the extraction of forest produce is being more and more appreciated, and this question was specially considered by the Board of Forestry in 1913. The conclusion arrived at was that, under Indian conditions, there was much scope for narrow-gauge forest tramways, and that experiments should be made with other means of mechanical transport likely to lead to cheaper methods of extraction.

While mechanical transport should be fostered, it should not be overlooked that in Europe the construction of roads is now the first care of the forester. They make the forests accessible, produce can be extracted along them by carts, waggons, trollies and road trains, and, if necessary, light railways can be laid on them at any time, if properly constructed. Thus, road traffic has, in most parts of Europe, superseded floating, and the expensive works erected for the latter purpose have been abolished. It may be mentioned that as early as 1875 an officer of the Royal Engineers was attached to the Department in Northern India to superintend forest engineering works. Now, after a long interval, a special Forest Engineer has been appointed, and is engaged on various projects. It seems clear that soon each province will have its own special Engineering establishment.

The Government of India have lately selected a number of men trained in mechanics and sent them for a year to the United States of America, where they have studied modern methods of transport and exportation of forest produce. They have lately joined the Indian Forest Department as Forest Engineers.

Quarters for the subordinates and rest houses for the inspecting officers are essential for the preservation of health in a climate like that of India. Efforts were made from the early days of the

Department onwards, but funds were limited. With the increase of the revenue more could be done, so that now considerable sums are devoted to such construction. During the five years 1909—1914 the average annual expenditure on communications and buildings was :—

	Rupees.
On Communications . .	849,363
On Buildings . . .	843,202
On Other Works . . .	123,700
Total . . .	1,816,265

This is at present equivalent to £181,626 a year.

10. Methods of Removal and Disposal of Produce.

Fuel, small timber, grazing and various kinds of minor produce required for local consumption near the forests are disposed of by special arrangements with the people. Large quantities of these classes of produce are given free of payment or at reduced rates. The removal of produce for commercial purposes is done either by private or Government agency. The question as to which of these agencies should be adopted has given rise to considerable discussion. Although general principles may be laid down, the choice of agency most suitable to any particular province or forest must depend on local conditions. The first duty of the trained staff is to administer, conserve and improve the forests, and the second is to secure, as far as the first permits, the greatest benefit to the proprietor. To obtain the latter, departmental or private agency should be employed as circumstances dictate. Provided that the systematic treatment of the forests is not interfered with, and that the proprietor receives a fair price for the produce, private agency may be freely employed, leaving the trained staff free for the first of the above-mentioned objects. But when it is found impossible to employ private agency on suitable terms, departmental working must step in. If this cannot be undertaken by the available trained staff without prejudice to the work of conservation and improvement, a separate staff, efficient in commercial exploitation, should be employed. In some cases,

departmental working is essential, as, for instance, in the extraction of little known timbers or other produce, for which it is desired to create a market, or when trade manipulations and the creation of a monopoly have to be prevented. On the whole, the Government of India are inclined to believe that in some parts of the country departmental working might profitably be employed more extensively than has been the case of late years.

There has been a noticeable increase in the demand for forest produce since 1914, and various industries dependent on the forests for their raw material have been started. Of these may be mentioned the utilization of bamboos, grasses and suitable woods for the manufacture of paper pulp, the extraction of tanning materials, the manufacture of matches, the utilization of new species of timber for railway sleepers, the impregnation of timbers with antiseptic substances, the manufacture of rosin and turpentine from crude resin obtained by tapping certain pines (*Pinus longifolia*) in the Himalayan forests, and other cases. The attempts to utilize most of these substances are not new; they were begun many years ago. The manufacture of paper pulp from bamboos was attempted in 1884, when the author was Inspector-General of Forests. Paper of excellent quality was produced by Messrs. Routledge & Co., but at that time the process employed did not permit the manufacture at a sufficiently low price. Sir Dietrich Brandis made a great effort to introduce the creosoting of Himalayan pines some 45 years ago, but the difficulty of keeping the creosote in a good condition was so great that the attempt had to be given up. Now the progress of science has been so great that such difficulties have disappeared, and the present day staff of the Department are fully alive to the importance of the commercial development of the forests; they recognise that efforts to secure commercial success are as much part of their duty as the scientific management of the property entrusted to their care. It may be added that of late a commercial branch of the Forest Department has been established.

11. Out-turn of the Forests.

The out-turn of the Indian State forests in the year 1913—1914 was as follows :—

I.—Wood, in Cubic Feet.

Agency.	Timber.	Fuel.	Total.
Government	7,655,518	13,632,994	21,288,512
Purchasers .	81,809,626	124,457,870	206,267,496
Free Grants .	4,299,819	18,894,872	23,194,691
Right Holders	3,460,207	40,432,417	43,892,624
Total in 1913	97,225,170	197,418,153	294,643,323
Total in 1920	—	—	339,515,833

II.—Other Produce, Value in Rupees.

Agency.	Bamboos.	Grazing and Grass.	Other Produce.	Total.
Government	47,367	162,578	508,868	718,813
Purchasers .	1,170,509	2,940,611	2,104,757	6,215,877
Free Grants .	29,401	607,302	280,140	916,843
Right Holders	58,276	2,670,618	217,914	2,946,808
Total .	1,305,553	6,381,109	3,111,679	10,798,341
In 1920	—	—	—	12,877,188

The produce came from the following classes of forest :—

Class of Forest.	Timber and Fuel.		Minor Produce.	
	Cubic Feet.	Per Cent. of Total.	Value in Rupees.	Per Cent. of Total.
Reserved forests .	185,988,403	63	8,211,087	76
Protected forests .	26,629,457	9	1,353,532	13
Unclassed forests .	82,025,463	28	1,233,722	11
Total . . .	294,643,323	100	10,798,341	100
Average of the 5 years, 1909—1913 . .	268,854,543	—	10,071,396	—

It will be observed that the greater part of the produce comes from the reserved State forests. As they contain 61,630,088 acres, the out-turn is equal to 3 cubic feet per acre and year. This is, no doubt, as yet a small yield, but it should be noted :—

(1) That a large proportion of the area is allotted to grazing, fodder grass and other minor produce ;

(2) That large areas were in a reduced condition when the Forest Department took charge of them ;

(3) That of the great variety of trees only a very limited number are as yet used for timber, while others are coming only gradually into use.

The out-turn from the protected forests amounts to 5 cubic feet per acre and year, and that from unclassed forests to about 1 cubic foot. The demand on the State forests is rising steadily, in the same degree as the yield capacity of private and communal forests decreases and the population increases.

12. Export of Forest Produce.

The export of forest produce in 1913—1914 is shown in the following table :—

Articles of Forest Produce.	Quantity in tons.	Value at Port of Shipment in Rupees.	
		Total.	Per Ton.
Caoutchouc, raw . . .	1,163	7,867,293	6,765
Lac, Button . . .	1,093	1,307,089	1,196
Lac, Shell	13,768	16,978,138	1,233
Lac, Sticks and others . .	2,097	1,372,774	655
Cutch and Gambier . .	2,943	932,438	317
Myrobolans	61,820	5,694,385	92
Cardamoms. . . .	167	749,919	4,491
Sandal, Ebony, Ornamental Woods	?	1,948,537	?
Teak	50,737	7,864,761	155
Other timbers . . .	7,935	709,784	89
Total . . .	—	45,425,118	—
Average of 5 years, 1909—1913	—	43,322,185	—
In 1920 . . .	—	117,826,638	—

Nearly half of these values is due to that of lac, and nearly one-fourth to that of timber, chiefly teak. On the whole, the exports of timber represent only about 3 per cent. of the yield of the State forests ; all the rest is used in the country, in addition to imports. The value of the forest produce given away free or at reduced rates in 1913—1914 amounted to Rs. 7,404,994, and in 1920 to Rs. 8,759,546.

13. Financial Results.

The subjoined table gives the annual averages for periods of 5 years since the establishment of the Indian Forest Department in 1864 :—

Quinquennial Period.	Revenue, Rupees.	Expenditure, Rupees.	Net Surplus, Rupees.	Percentage of Surplus to Gross Revenue in per cent.
1864—1869	3,740,000	2,380,000	1,360,000	36
1869—1874	5,630,000	3,930,000	1,700,000	30
1874—1879	6,660,000	4,580,000	2,080,000	31
1879—1884	8,820,000	5,610,000	3,210,000	36
1884—1889	11,670,000	7,430,000	4,240,000	36
1889—1894	15,950,000	8,600,000	7,350,000	46
1894—1899	17,200,000	9,800,000	7,920,000	45
1899—1904	19,660,000	11,270,000	8,390,000	43
1904—1909	25,700,000	14,100,000	11,600,000	45
1909—1914	29,600,000	16,370,000	13,230,000	45
1913—1914 only.	33,301,000	17,543,000	15,758,000	47
1919—1920	52,243,199	30,340,840	21,902,359	42

During the 50 years, up to 1914, the revenue has increased nearly tenfold, and the net surplus tenfold. The percentage of net revenue to gross revenue was steady at 36 per cent. from 1864 to 1889. Owing to the occupation of Upper Burma it then rose to 46 per cent., and it kept fairly steady up to 1914. The great rise in revenue between 1914 and 1920 was due to the effects of the war, and there may be a temporary reaction, but on the whole the revenue is sure to rise for many years to come. Forty years ago the author predicted that the forest revenue would some day become a set-off against the declining opium revenue,

and it seems that the realisation of this prediction is not far off, provided that the conservation and rational management of the Indian State forest is maintained. The value of the produce given free is not included in the above table.

14. Research.

It has been shown above that the activities of the Forest Department were, until the commencement of the present century, chiefly directed to the selection, settlement and demarcation of an enormous forest estate, as well as to its organisation and systematic management. Moreover, protection and exploitation occupied much of the time of the very moderate staff. The latter increased only slowly and not in proportion to the increase of the work. Nevertheless, a very considerable amount of scientific work was done during the first 40 years after the establishment of the Department in 1864, partly at the instance of the Government, but chiefly as the result of individual effort on the part of enthusiastic members of the staff.

Naturally, botanical questions were the first to occupy foresters. The flora of the forests was studied in most parts of India. In this connection may be mentioned Brandis' " Flora of North-west and Central India " ; Kurz' " Forest Flora of Burma " ; Gamble's " Indian Timbers " ; Beddome's " Forest Flora of Madras " ; Brandis' " Indian Trees," a monumental work commenced many years ago, though not published until 1906 ; Gamble's " Indian Bamboos," and others. By the establishment of the Working Plan Branch in 1884, the foundation was laid for the collection of statistics on matters referring to the silviculture, management and yield of the forests. Numerous investigations were recorded in many reports and other publications.

Another branch which occupied the staff from the early days of the Department was the introduction to the market of timbers which were as yet not appreciated by the people and commerce of the country. To illustrate this point it may be mentioned that as early as 1876 thousands of sleepers of a variety of species were cut and placed into several railway lines to test their durability. Experiments were made about the same time to creosote so-called inferior species which at that time were not successful, because the creosote obtained from England would not keep in good

condition. While the author was Inspector-General of Forests consignments of bamboos were sent to England, from which, as stated above, Messrs. Routledge manufactured paper, some of which was used by the author for letter writing. The possibility of manufacturing paper from Indian bamboos was thus established, but was not started at that time on commercial lines, because the process of treating the bamboos was not sufficiently developed to make the undertaking financially successful. These difficulties have now been overcome, and there is no reason why the manufacture of paper from bamboos should not develop into a flourishing industry.

The condition of forest conservancy in India at the beginning of the twentieth century, as described above, was the result of the labours of a staff which had seen and learned to appreciate the results of systematic management and of research as practised in continental European countries in the course of more than a century. The forest estate was now ready, and the time had arrived for more independent action. An Institute for organised Forest Research was established in 1906, at the instance of Sir Sainthill Eardley-Wilmot, at that time Inspector-General of Forests, in connection with the Forest College, at Dehra Dun. The Research Institute is in the charge of a President, who is under the administrative control of the Inspector-General of Forests. It is divided into the five main branches of Silviculture, Forest Economic Products, Forest Botany, Zoology and Chemistry, each branch being in the charge of a Research Officer with the required number of Assistants. The research officers are picked members of the general forest staff. There are also Specialists, temporarily appointed, for investigations in subjects of special economic importance, such as cellulose and tannin experts.

The work of the Silviculturist comprises a study of the requirements of the more important species of trees, the collection of statistics relating to the rate of increment and volume production of forest crops, the improvement of methods of treatment and management generally, the preparation of working plans on improved lines, and allied subjects.

The activity of the Forest Economist covers a wide field, such as the properties and uses of timbers, their durability, the antiseptic treatment of timber, its suitability for railway sleepers,

the manufacture of paper pulp from bamboos and other vegetable produce, the utilization of Indian timbers for industrial purposes such as for matches, pencils, paving blocks, railway waggons, investigations about minor produce such as tan, bark, gums, resin, oil seeds, grasses, fibres, and the production of lac, a subject of the first importance, especially from a financial point of view.

The Forest Botanist deals with systematic botany, the identification of specimens for forest officers, the measures taken for the preparation of local floras and lists, the ecology of important species and their diseases, the study of forest grasses and allied subjects; the present holder has made a special study of soil aeration.

The Forest Zoologist deals chiefly with injurious and useful forest insects, the identification of specimens for forest officers, the upkeep of the entomological collection, etc.

The Forest Chemist works in close touch with the other research officers, especially with the forest economist. He has lately been occupied with the tanning value of barks and other products, the distillation of oil from grasses, pine needle and Deodar waste, the improvement and standardisation of Indian turpentine and rosin. Since the outbreak of the war the Forest Chemist has been intimately concerned with the manufacture of thymol and salicylic acid. He produced oil of wintergreen and salicylic acid from the leaves of *Gaultheria fragrantissima*, leading to aspirin. There is every prospect that other substances will be manufactured for which the forests yield the raw material.

The results of all investigations are published in leaflets, pamphlets, bulletins and memoirs. Of these more than 150 have already appeared, indicating the zeal with which the investigators have taken up the work. In all research work it is essential to aim at a high standard.

When the Working Plan Branch was established in 1884 it was foreshadowed that after a time the work must be provincialised. In the same way it was soon realised that one research institute was not sufficient for such a large country as India with its great diversity of climate and other conditions. Some classes of research work can be done at a central institution, but others must be done locally, and this is specially the case with forest research. More particularly, questions connected with silviculture and

working plans must in the first place be investigated in the forest. While Dehra Dun will remain the central institute, a beginning has been made in the appointment of provincial research officers, a measure which will, no doubt, soon lead to the establishment of local institutes; they will, however, remain in close communication with the central establishment at Dehra Dun.

In various respects, the Dehra Dun institute has already produced good results, but research takes time, and patience must be practised. There can be no doubt that in time research will considerably further advance the great results obtained in Indian forest conservancy during the first 40 years of the Forest Department's existence.

SECTION VI.—FUTURE DEVELOPMENT OF FOREST CONSERVANCY.

The development of Indian forest conservancy up to date has had a decided influence upon the management of the forests in other parts of the British Empire. It has acted as an illustration of what should be done, and from an early date onwards the Governments of other parts of the Empire have asked the loan of Indian forest officers to advise them. Officers have been lent to Ceylon, the Federated Malay States, Mauritius, New Zealand, Australia, South, West, and East Africa, the Sudan, Cyprus and the West Indies. It has had even an influence upon the development of forest conservancy in the United States of America and of Canada. Last, but not least, the results of forest conservancy in India have awakened, or intensified, the knowledge in the United Kingdom that systematic forestry resting on a scientific basis has become an absolute necessity for all parts of the Empire.

In the meantime, India is not satisfied with the results achieved in the past; she is determined to advance further. As has been shown, the financial results have developed so well that the means required for further expansion are available. Stimulated by the experience gained during the war, action is being taken in a variety of directions. As already stated, the average annual yield of the State forests is as yet small, about 3 cubic feet per acre. This yield is, however, taken from the more conveniently situated parts of the forests and selected species, while extensive areas are as yet inaccessible to traffic. Under these conditions, the efforts of the Department in the immediate future will be

directed towards the introduction of improved methods of treatment and the construction of roads and other means of transport. As regards the former, the usual selection system should be replaced by more concentrated methods, such as the uniform system of regeneration or one of its modifications. A commencement has been made in that direction, and the conversion should now be extended to larger areas. During this process care should be taken to increase the percentage of the more valuable species, though it would be a doubtful proceeding in the case of several species to produce pure woods. Observation in the forest, combined with research in the laboratory, will show the best way of achieving the object. The opening out of the country by means of roads and other works is of great importance. As early as 1875 a Royal Engineer officer was attached to the Department to assist in the construction of such works, and the plan now is to organise a special Engineering Branch of the Department. By these two measures combined it will be possible to increase, in the course of time, the production of valuable species, and to bring them to the centres of consumption, when, in consequence of the exhaustion of the unreserved and private forests, the demand on the permanent State forests has increased.

Other important measures are the introduction into commerce of hitherto rejected or unknown species, the extended utilization of produce other than timber, and a vigorous development of forest industries. With this end in view, a number of experts have lately been engaged who are now at work on timber testing, timber seasoning, preparation of paper pulp, wood technology and preservation, tanning materials, &c.

All these measures and others depend, however, on the employment of a thoroughly competent staff, and it should be the Government's first care to see that the education of the recruits of the Department is of the highest possible standard. It should be on a par with that of the highest branch of the Government service, so that the members of the Forest service may take that place in the State which belongs to them by virtue of their being the guardians of practically one-fourth of the area of the country, containing an asset of enormous potential value, capable of a degree of development far beyond that which it has as yet obtained.

The Indian State forests are throughout managed on the

principle of a sustained and increasing yield, and this has been brought about without interfering with the acknowledged rights of the people. In the early days of forest conservation, no doubt, some friction occurred between the forest staff, the people, and the civil officers, but that was chiefly due to the unsettled condition of the rights of the people. As the settlement of the State forests proceeded, these difficulties disappeared. It may safely be said that, in many parts of the country, the people now recognise the importance to themselves of the proper preservation of the yielding power of the forests.

The example set by the Government of India has been followed in most of the Indian States, by introducing forest administration on lines similar to those adopted in the British part of the country. The Government have readily assisted in this by lending officers and educating recruits for the Indian States at Dehra Dun.

There can be no doubt that the development of systematic, economic forest management in India is something to be proud of. An eminent Indian Administrator had no hesitation in stating publicly that it ranks amongst the great achievements realised during the long and glorious reign of Her Most Gracious Majesty, the late Queen Victoria and Empress of India.

THE BRITISH DOMINIONS.

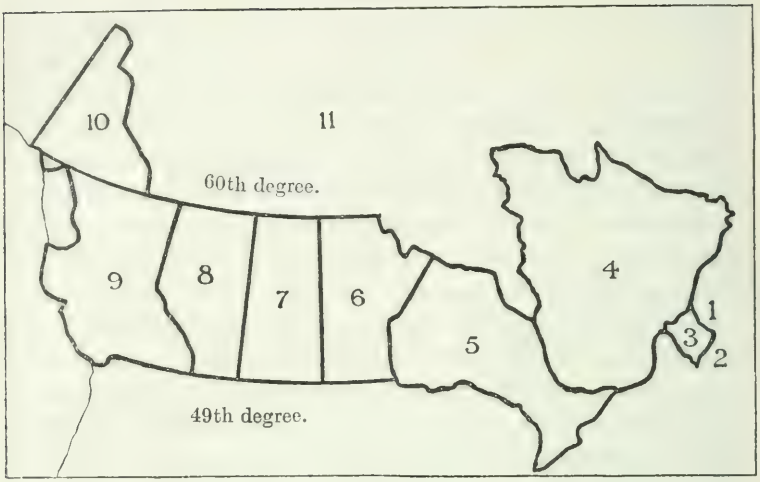
D. FORESTRY IN CANADA.

SECTION I.—SHORT DESCRIPTION OF THE COUNTRY.

The Dominion of Canada occupies the northern half of North America. The boundary between it and the United States runs from the Bay of Fundy in latitude 45, in a somewhat zig-zag way, to Lakes Ontario, Erie, Huron and Superior, then on close to Winnipeg, from which place it follows the 49th degree of northern latitude to Vancouver Island. Alaska is the only part to the north of this line which is not Dominion land. The latter covers an area of 3,729,665 square miles, of which 125,755 square miles are water. The population amounted, in 1911, to 7,209,643 people.

The area between the southern boundary and the 60th degree of latitude is divided into the undermentioned 9 provinces. Above the 60th degree are situated Yukon and the North-west Territories.

FIG. 8.



Sketch Map, showing the relative position of the several Provinces of Canada.

1. Prince Edward Island.
2. Nova Scotia.
3. New Brunswick.
4. Quebec
5. Ontario.
6. Manitoba.
7. Saskatchewan.
8. Alberta.
9. British Columbia.
10. Yukon.
11. North-west Territories.

Province.	Area, Square Miles.	Population in 1911. Total.	Per Square Mile.
1. Prince Edward Island	2,184	93,728	43
2. Nova Scotia	21,428	492,338	23
3. New Brunswick	27,985	354,889	13
4. Quebec	706,834	2,003,232	3
5. Ontario	407,262	2,523,274	6
6. Manitoba	251,832	455,614	2
7. Saskatchewan	251,700	492,432	2
8. Alberta	255,285	374,663	1·5
9. British Columbia.	355,855	392,480	1·1
10. Yukon	207,076	8,512	0·04
11. N.W. Territories.	1,242,224	18,481	0·01
Total	3,729,665	7,209,643	2·0

1. CONFIGURATION.

Canada, extending from the 42nd degree of latitude to the arctic regions, and from the 56th to the 141st degree of West longi-

tude, has a somewhat complicated physical configuration. The maritime provinces, Nova Scotia, Prince Edward Island, New Brunswick, as well as the part of Quebec south-east of the St. Lawrence, are hilly, though the highest points do not reach any great height. There are coal measures at the bottom of the valleys which in Nova Scotia extend a considerable distance under the sea. Prince Edward Island has gentle, rounded hills with rich soil and low shore cliffs. There are extensive areas of low lands in the St. Lawrence valley, as well as in the southern part of Ontario. These lowlands extend over 35,000 square miles and support 4 out of the 7 million inhabitants.

Quebec, Ontario, Manitoba and the eastern part of the Territories are arranged around Hudson Bay. All around the latter, enormous areas of lowlands are found, but on receding from the bay the ground rises, though only exceptionally to 1,500 or 2,000 feet above sea level. In these areas, situated in Quebec and Ontario, the great forest wealth of Eastern Canada is found.

On going west towards Winnipeg the prairie country is reached. These plains extend for some 800 miles westward to the foot of the Rocky Mountains in Alberta. The plains are, however, not quite level; at Winnipeg the prairie is 700 feet above sea level, while Calgary has an elevation of 3,400 feet, showing an average rise westward of over 3 feet per mile. The rise is not uniform; in the southern part, two abrupt rises occur so that three distinct sections can be observed at the average elevations of 800, 1,600 and 3,000 feet above sea level. These differences are much less distinct in the north; indeed, there is a slow descent, so that Edmonston lies 1,200 feet lower than Calgary. There occur also numerous local elevations over the general level. On going west the plains pass gradually into the foothills and then into the Rocky Mountains, which here form the south-western boundary of Alberta. They extend from the 49th degree for at least 1,100 miles in a north-western direction, and they are continued for an additional 500 miles by the Mackenzie Mountains to the Arctic Ocean. Between the eastern chain of Rockies and the Pacific coast lies a broad belt of mountainous country called the Cordillera, which extends south through the western United States and on to the Andes of South America, though they differ

much in different parts. In Canada, the Cordillera consist of four ranges of mountains of which the Rockies are the highest, rising in the central parts to 13,000 feet with a distinctly alpine character. The timber line is at 7,500 feet elevation. The coast ranges seldom rise to 9,000 feet. The Klondike region and the country around it is described as a tableland with the highest elevation of 3,500 feet above the sea. In the south-west corner of Yukon the St. Elias range rises up to 18,000 feet elevation.

A great part of the outermost coast range in British Columbia is submerged, leaving Vancouver Island and Queen Charlotte Islands above sea. The former has beds of excellent coal, many of the mines being under the sea, just as those in Nova Scotia. Vancouver Island consists of a great mass of mountains rising to 9,000 feet elevation.

2. Geology and Soils.

The geological features are very varied in such an enormous extent of country. The Rocky mountains consist chiefly of palæozoic rocks, also the islands on the west coast. The coast range is chiefly granitic. The intervening ranges are of mixed formations varying from rocks of sedimentary origin to granites. To the east of the Rocky Mountains in the prairie country, the underlying rocks are of sedimentary origin of the tertiary and mesozoic ages. The basin of the St. Lawrence river and the great Lakes contain a variety of geological types, partly of the southern Laurentian type and partly of sedimentary origin of the palæozoic age. The rock formation in New Brunswick is largely mesozoic with areas of granite. In Nova Scotia the proportion of granite is greater with large areas of late pre-cambrian or cambrian rocks. The most fertile valleys in the last-mentioned two provinces are underlaid with Mississippian palæozoic rock. Prince Edward Island is built up of permian and upper carboniferous rocks.

The best soils are concentrated in the valley bottoms of the hilly parts and in alluvial deltas. The soil in the great interior basin is rich and fertile, forming an agricultural and pastoral country. The land in the Lake region and in the St. Lawrence

valley is of great agricultural value, on which more than half the population of Canada lives.

3. Climate.

It will easily be understood that the climate of Canada differs considerably in the various parts of the country. These differences are best illustrated by the rainfall. The high mountains of the west intercept the rainbearing clouds from the Pacific Ocean, producing, along the west coast, a strip of high rainfall up to 100 inches. A somewhat diminished but still considerable rainfall is experienced up to the watershed of the Rockies. After passing that chain, the remaining clouds descend in their eastern passage, and the rainfall diminishes considerably, so that Calgary, in Alberta, shows a fall of only 16 inches, Regina, in Saskatchewan, of 18 inches, and Winnipeg, in Manitoba, 20 inches. Proceeding further east the rainfall increases again, the country coming under the influence of easterly air currents, as well as under that of the Lakes and of Hudson Bay. Thus, Toronto, in Ontario, has a fall of 34 inches, Montreal, in Quebec, 41 inches, Charlottetown, in Prince Edward Island, 42 inches, Fredericton, in New Brunswick, 44 inches, and Halifax, in Nova Scotia, 55 inches. Precipitations decrease, not only on proceeding from both coast lines towards the interior, but also on going north. Over the greater part of Canada much of the precipitation is in the form of snow.

Southern Canada lies within the cool temperate zone with rather cold winters and hot summers. On going north the temperature falls and the severity of the winters increases, until vegetation disappears, so that three distinct zones may be distinguished :—

(1) The Temperate Zone, comprising (*a*) the eastern or Atlantic forest region, extending to the Great Lakes, (*b*) the central drier region of prairies, and (*c*) the western or Pacific forest region.

(2) The Sub-arctic Zone, a continuous area of coniferous forests, less luxuriant than the forests of the temperate zone, stretching obliquely across the entire continent.

(3) The Arctic Zone, comprising mainly desolate stretches of treeless country known as "tundra."

SECTION II.—THE FORESTS OF CANADA.

1. Area and Ownership.

Canadian Statisticians have, for practical purposes, divided the country into the following two parts :—

(1) Area north of latitude 60, comprising 1,242,225 square miles.

(2) Area south of latitude 60, comprising 2,487,440 square miles.

The former of these two areas is situated in the sub-arctic and arctic regions, and it cannot, for many years, become an important source of agricultural or forest produce.

As far as the available data permitted, the area of Canada has been classified as follows :—

	Agricultural Land.	Forests.			Other Land.	Total.
		Merchantable.	Unprofitable or Remote.	Total.		
Square Miles .	689,062	390,625	541,791	932,416	2,108,187	3,729,665
Percentage of total area .	18·48	10·47	14·53	25·00	56·52	100·00

The agricultural lands and the merchantable forests are all situated south of the 60th degree of latitude, while the unprofitable and remote forests stretch across it. Of the agricultural land about one quarter is occupied as farm land, of which 66,566 square miles were under field crops in 1917. There is thus plenty of room for extensions. It will be seen that the total forest area is about one quarter of the total area. Of that area only 390,625 square miles are estimated to contain saw timber above 10 inches diameter on the stump, and of that area much is as yet inaccessible due to the difficulty of transportation. Much of the material below 10 inches is profitable to cut wherever a demand exists for pulpwood, crossties, poles and minor produce.

The Dominion Government administers the following areas :—

(1) The Crown lands in the three Prairie provinces Manitoba, Saskatchewan and Alberta.

(2) The Crown lands in the Railway belt, 20 miles broad on each side of the Canadian Pacific Railway main line in British Columbia.

(3) The Crown lands in the Peace River block in northern British Columbia.

(4) The Crown lands in the North-west Territories.

The Crown lands in the several Provinces are administered by the local Governments.

In Nova Scotia the geater part of the timber lands has become private property. In New Brunswick over 7,000 square miles of forest land is owned by railway companies and other private concerns or individuals. In Quebec about 9,500 square miles have been disposed of, and in Ontario about 7,800 square miles. In British Columbia about 2,000 square miles are privately owned, but the title to all the other timber lands has been retained. The policy of disposing of the title to lands fit only for the production of timber has now been virtually abandoned in every part of Canada.

The following statement shows the present state of ownership ; it was not possible to separate the areas owned by corporate and private individuals :—

	Area belonging to the State.			Corporations and Private Owners.	Total.
	Dedicated to Timber Production.	Other Forests.	Total.		
Square miles . .	234,341	635,575	869,916	62,500	932,416
Percentage of total forest area . .	25·14	68·16	93·30	6·70	100·00

The following statement shows the distribution and classification of the 234,341 square miles of Crown forests dedicated to timber production :—

Province.	Dominion Reserves.	Provincial Reserves.	Dominion Parks.	Total Square Miles.
British Columbia .	2,719	90	1,028	3,837
Alberta . .	19,434	—	6,744	26,178
Saskatchewan .	9,303	—	—	9,303
Manitoba . .	3,729	—	—	3,729
Ontario . .	—	22,548	—	22,548
Quebec . .	—	168,746	—	168,746
Total . .	35,185	191,384	7,772	234,341

2. Types of Forest Growth.

The Pacific Slope Forests.—These are divided into four types ; The Coast, Dry Belt, Wet Belt and Interior Mountain Forests.

The Coast Type includes the forests of Vancouver Island, Queen Charlotte Islands and the coast of the opposite mainland, all of which have a moderate temperature and a heavy rainfall. This type consists almost entirely of conifers with a small quantity of cottonwood,* birch, alder and maple. The chief conifers are Douglas fir, 29 per cent. ; western red cedar, 28 per cent. ; western hemlock, 25 per cent. ; balsam fir, 9 per cent. ; spruces, 7 per cent. ; and yellow cypress, 2 per cent.

The Dry Belt, away from the coast, contains a mixture of western yellow pine, Douglas fir and western larch, with a rainfall of 14 to 25 inches.

The interior West Belt type is composed of a mixture of western red cedar, hemlock, Engelmann spruce, and a variety of other species.

The interior Mountain Forests contain chiefly spruce types with alpine fir (*Abies lasiocarpa*) and lodge-pole pine. Associated with these are poplars, willows, birch, alpine larch (*Larix Lyalli*) and mountain hemlock in the higher altitudes.

Some of the above-mentioned important species of British Columbia extend into the western part of Alberta, but not to any great distance.

The Atlantic Forests.—These include all the Canadian forests to the east of the Rocky Mountains. Sufficient information is not available to give a detailed description of the various types, which, on the whole, do not seem to vary much in character.

The northern limit of the forests is indicated by a line running from the mouth of the Mackenzie river to the mouth of the Churchill river on Hudson Bay, round the latter and on to Labrador peninsula, except the north-east corner of Quebec. In the northern part of this tract the climate is severe and the growth more or less stunted ; on going south conditions improve gradually. The principal species are white spruce, jack pine, balsam fir, tamarack and black spruce, with an admixture of aspen and poplar. To the south and east conditions improve greatly, spruce

* For systematic names of trees, see pages 181 to 184.

and balsam fir prevail and become the great pulpwood district of Eastern Canada.

On entering the St. Lawrence basin the type changes into forests of white pine, red pine, cedar and valuable hardwoods, such as yellow birch and maple. In the maritime provinces and Quebec the red spruce is a conspicuous component part of the coniferous forest. This is the most important timber producing part of Eastern Canada.

The southern part of Ontario was originally an almost pure hardwood forest, which has now given way to agriculture. Certain species are still found along the northern shores of Lakes Erie and Ontario, which do not occur elsewhere in Canada, such as the tulip tree, sycamore, chestnut and black walnut; cottonwood also appears here.

3. The Produce of the Forests.

The principal products of the Canadian forests are sawn lumber and pulpwood. At least 130 species reach timber size, of which about 70 are sawn into lumber. The conifers are by far the most important trees, while the broad-leaved trees give only about 3 per cent. of the produced lumber. Other products are railway sleepers, poles, piles, mining timber, fencing material, firewood, wood for distillation, tanning bark, maple sugar and syrup, balsam, spruce gum, nuts, and other items.

The trees mentioned in the following notes are arranged according to their importance as sources of the various products:—

Spruces, 6 species, of which 5 are of commercial value.

(1) White Spruce (*Picea canadensis*), of moderate size, appears in every province, important as timber and pulpwood.

(2) Sitka Spruce (*P. Sitchensis*), a very large tree, confined to low altitudes along the coast of British Columbia, valued for airplane construction and for pulpwood.

(3) Red Spruce (*P. rubra*), of moderate size, confined to eastern Quebec and the maritime provinces, lumber and pulpwood.

(4) Engelmann Spruce (*P. Engelmanni*), a larger tree than the white and red spruces, but smaller than Sitka, found in British Columbia, used for lumber but not yet for pulp.

(5) Black Spruce (*P. mariana*), a swamp species throughout the Dominion, the smallest of the spruces, occasionally sawn into lumber and much used for pulpwood.

White Pine, 2 species.

(6) Eastern White Pine (*Pinus Strobus*), formerly the most important tree of Canada, but now much reduced in quantity, highest development near the great lakes, reaches up to 150 feet in height and 3 to 4 feet diameter, used for building construction and cabinet work, not used for pulpwood.

(7) Western White Pine (*P. monticula*), even a larger tree than the former, but not very plentiful, found scattered in the south-western districts and the interior wet belt of British Columbia.

(8) *Douglas Fir* (*Pseudotsuga Douglasii*), in British Columbia in the southern part of the coast region, and throughout the interior to about the 55th degree of latitude and extending to the foot hills of the Rockies in Alberta ; very large tree, Canada's finest wood for structural purposes, height up to 250 feet and 8 feet diameter in the southern part of the coast range, smaller in the interior, used for lumber, sleepers, piles, mining wood, block paving, and many other purposes.

Hemlock, 3 species, of which 2 are of commercial importance.

(9) Eastern Hemlock (*Tsuga canadensis*), found in South Ontario and Quebec and throughout the maritime provinces.

(10) Western Hemlock (*Ts. heterophylla*), found in British Columbia throughout the coast region, also in the interior wet belt as far north as the upper Fraser valley and in Alaska ; a larger tree than the eastern hemlock, and its wood is of superior quality ; the second most important pulpwood species in British Columbia.

Cedar, 2 species, also known as Arbor-vitæ.

(11) Western Red Cedar, or Giant Arbor-vitæ (*Thuya plicata*) found in regions of abundant precipitations in British Columbia, reaching in Vancouver island a height of 175 feet and 10 feet diameter, extends along the coast into Alaska, missing the dry belt and re-appearing in the interior wet belt, extending to the upper Fraser valley.

(12) Eastern Cedar (*Th. occidentalis*), found from East Manitoba to the Atlantic seaboard in moist situations, a smaller tree than the western species.

The wood of both species is durable, but the texture is rather coarse, the eastern species being more uniform in texture.

(13) *The Red Pine* (*Pinus resinosa*) is found in eastern Canada in the same region as the white pine. Its wood is stronger and more resinous.

(14) *The Balsam Fir* (*Abies balsamea*). This is the most important of four species. It is found throughout Canada, but is most important in Ontario, Quebec and the maritime provinces. The tree is sawn into lumber, but more important as pulp-wood in connection with spruce.

(15) *The Western Yellow Pine* (*Pinus ponderosa*) is confined to the interior dry belt of British Columbia, where it forms the key tree of that region; its wood is intermediate in quality between white and red pine.

Birches, 7 species, of which 3 are of commercial value.

(16) The Yellow Birch (*Betula lutea*) is the most important hardwood of Canada, appearing from the maritime provinces to the east end of Lake Superior, and reappearing between the west end of that lake and the Lake of the Woods. Used extensively for flooring, cabinet work, vehicle stock, and handles; takes a fine polish.

(17) The Western Birch (*B. occidentalis*) is confined to south-western British Columbia and is used for lumber and cabinet work.

(18) The Paper or Canoe Birch (*B. alba var. papyrifera*) is the most widely spread birch in Canada; inferior to the other two species for lumber, but valued for turnery and fuel.

Larch or *Tamarack*.

(19) The Eastern Larch (*Larix laricina*) is a swamp tree; appears in all provinces of the Dominion, never abundant; has been almost entirely destroyed in eastern Canada by the larch saw-fly. Wood very strong, hard and durable; used for lumber, sleepers and shipbuilding.

(20) The Western Larch (*L. occidentalis*), a much larger tree with similar wood ; height up to 180 feet and diameter 3 to 4 feet. Valued for railway sleepers, poles, structural purposes and shipbuilding.

The following species are of local importance, and in some cases also for export :—

Maples :

(21) Sugar Maple (*Acer saccharum*), for the manufacture of sugar, and also valuable as timber.

(22) Silver Maple (*A. saccharinum*).

(23) Red Maple (*A. rubrum*).

(24) Broad-leaved Maple (*A. macrophyllum*).

(25) Jack Pine (*Pinus Banksiana*), an eastern species.

(26) Lodgepole Pine (*P. Murrayana*), a western species. Both these pines will grow on poor sites.

(27) Beech (*Fagus grandifolia*), a fairly valuable wood.

(28) The Rock Elm (*Ulmus fulva*), valuable wood for waggon work.

(29) The Wild Elm (*U. americana*), valuable wood for waggon work.

(30) Basswood (*Tilia americana*), a soft wood, prized for joining.

(31) Aspen (*Populus tremuloides*), widely distributed ; often a weed.

(32) Balm (*P. balsamifera*), widely distributed ; often a weed.

(33) The Western Cottonwood (*P. trichocarpa*), a valuable timber in south-west British Columbia.

(34) White Ash (*Fraxinus americana*), a valuable species ; wood used in vehicle work.

(35) White Oak (*Quercus alba*).

(36) Red Oak (*Q. rubra*). The supply of both these oaks is almost exhausted. There are 10 other species of oak of less importance.

(37) The Yellow Cypress (*Chamæcyparis nootkatensis*), a British Columbia species, yielding timber of high technical value for shipbuilding and joinery ; comparatively scarce and scattered.

A few valuable cabinet and vehicle woods are found in small quantities in south-western Ontario, such as Chestnut (*Castanea*

dentata), hickory (*Carya cordiformis, alba, glabra*, and *microcarpa*), butternut (*Juglans cinerea*), walnut (*J. nigra*), cherry (*Prunus serotina*), tulip tree (*Liriodendron tulipifera*), and others.

4. Relationship of the State to the Forests.

(a) *Legislation.*—The Government forests in the three Prairie Provinces and certain lands in British Columbia are under the direct management of the Dominion Government, while those in the other provinces are under the control of the provincial Governments. Some of the Dominion Acts apply to all provinces, and others only to the areas under the direct administration of the Dominion Government.

The Dominion.—The existing legislation on forestry is scattered through a number of Acts, of which the most important is the Forest Reserves and Parks Act, passed in 1906 and subsequently frequently amended. It authorises the setting aside of unoccupied land for Forest Reserves and Dominion Parks, to be subject to Regulations issued under the authority of the Governor-General in Council. The objects of these reservations are :—

(1) The maintenance of the timber supply.
(2) The conservation of the minerals, game and fish therein.
(3) The preservation of the water supply.
(4) The preservation of historic sites.

No power is granted to interfere with rights granted on lands included in the reservations, but timber births, cut over or given up, may be reserved. Power is given to forest officers to seize and summarily arrest in case of infraction of the Regulations. The latter govern the use of fire for legitimate purposes, the disposal of timber by permit or sale, the grazing, hay-making, fishing, hunting, mining, and the establishment of town sites and summer resorts.

A feature common to the timber administration of the Dominion Government and that of the provinces of Ontario, Quebec, New Brunswick and British Columbia is that the law prohibits the alienation of the land in issuing timber-cutting licences, which give only the right to cut timber. All such licences also prohibit the export of unmanufactured timber cut on the lands covered by the licences.

The patrol of railway lines is compulsory throughout the

Dominion for the prevention of fires caused by locomotives and railway operations generally.

British Columbia.—By the Forest Act of 1912, with subsequent amendments, the forest branch of the Department of Lands has entire charge of the forests, including the collection of revenue from woodlands, sales and tenancy of timber lands. Before licences to cut timber are granted the land must be examined; the timber may be auctioned or disposed of by tender. The Timber Royalty Act of 1914 fixed the charges, and they are revised every 5 years. The Forest Fire Act provides a close season from May 1st to October 1st, during which period burning in forest areas is allowed only by permit. Debris arising from forest operations must be burned.

Ontario.—The Forest Fires Prevention Act of 1917 provides for the appointment of a Provincial Forester to enforce its provision for a closed season as regards fires. The Forest Reserves Act provides for the setting aside of forest reserves, and empowers the Lieutenant-Governor in Council to issue regulations governing these reserves.

Quebec.—The forests are administered by the forestry branch of the Department of Lands and Forests. Timber lands are virtually leased in perpetuity to licence holders, the Crown retaining a title of the land. Licence holders are required to patrol their own limits, and a close fire season is provided.

New Brunswick.—The Forest Act of 1918 establishes a forest service under the Ministry of Lands and Forests, which administers all statutes and regulations respecting forestry, hunting, fishing, game protection, fire protection, improvements on Crown forests and re-afforestation. It is aided by a forestry advisory board. The Act provides a close season for fires. The Lieutenant-Governor in Council has power to revise the regulations and rates of stumpage from time to time. Pulpwood cut on Crown lands must be converted into pulp in the country.

Nova Scotia.—The greater part of the timber lands has passed into private ownership. Leases of timber lands are granted for a term of 20 years, the title in the land remaining with the Crown; the rental charge is fixed by the provincial land surveyor with a minimum of 1 dollar per acre. The Forest Protection Act of 1913 provides for fire protection.

(b) *Administrative Methods.*—The forests of the Dominion of Canada are administered with the object of maintaining a permanent supply of timber and firewood, in the first place for the people of the country, and in the second place for export. Hence, the forests must be administered for a sustained yield. Unfortunately in some parts of the country a large proportion of the best forests has been permanently disposed of to private people, but it is stated that the policy is now to retain the title to the land wherever this is still possible. Efforts are also made to control the execution of the leases, more particularly to see that the operations under each lease are completed at the fixed time, and that they are executed in such manner that they do not seriously interfere with the natural regeneration of the forests.

There can be no doubt that a great effort is being made to keep down forest fires, which in the past have destroyed far more material than even the most reckless exploitation. There are forest Fire Acts in practically every province ; a regular system of fire guards has been established ; close seasons for lighting fires in the forests have been introduced ; special contrivances have been elaborated for the discovery of fires, so as to extinguish them before they have attained an unmanageable extent. In this way it is hoped to reduce the destruction by fire, but the task is very difficult owing to the huge extent of the areas to be controlled.

(c) *State Assistance given to Forestry.—The Dominion Government* provides for the distribution of tree-planting material and furnishes expert advice to private owners.

In British Columbia the shortness of the staff has, so far, prevented assistance being given to private holders of timber lands, and no provision has been made to provide nursery stock for them.

Ontario distributes nursery stock, gives expert advice, an annual grant to the Canadian Forestry Society and, in supporting Toronto University, gives indirectly assistance to forestry education at that institution.

Quebec distributes nursery stock, gives expert advice and a grant to the Canadian Forestry Society. The province supports the School of Forestry at Loval University. Provision is made for the creation of township and communal forests. Land orders are given to settlers and others for each acre of land planted with forest trees.

New Brunswick has not yet made provision for the distribution of nursery stock, but expert advice to timber holders is said to be available. An annual grant is given to the Canadian Forestry Society. Financial assistance has been given to the Dominion Bureau of plant pathology and to the Dominion entomological branch for the balsam bud-worm investigation.

In Nova Scotia no assistance is given to forestry.

(d) *The Forest Authorities.*—The forest authorities of Canada are not easy to describe. They are very numerous and it is difficult to say, from the records to hand, where and to what extent they overlap. Each province has its own arrangement as well as the Dominion Government. Under these circumstances it will suffice to indicate the duties and powers of the authorities in the Dominion, some of which hold good in the provinces.

The timber lands are administered by three different branches of the Department of the Interior of the Federal Government. They are :—

(1) *The Forestry Branch.*—It has its headquarters at Ottawa and is presided over by the Director of Forestry. Its activity extends to the administration of forest reserves, fire protection, forest surveys, tree planting and products research.

Each reserve of sufficient importance has a Forest Supervisor with the necessary staff. The reserves are arranged into four Inspections, each in charge of a District Inspector, who organises and controls the general administration of the reserves. Forest Rangers are in charge of smaller reserves.

Fire protection in reserves and in their immediate vicinity is carried on by the reserves staff. For Dominion lands outside forest reserves a special staff has been organised under a specialist at the head office. The protection of forests from fire along railway lines on Dominion lands is under a separate organisation.

Forest Survey work is under the charge of the Chief Surveyor at the head office, who organises the required number of survey parties and controls their work, which includes reconnaissance surveys to determine the suitability of Crown lands for forest production, and the estimation of standing timber on certain areas.

The Forest Statistician at head office compiles and publishes statistics on forest products and investigates wood-using industries.

The forestry branch also maintains at headquarters a technical Forester, who gives advice to farmers and woodowners throughout Canada free of charge, except travelling expenses.

The Chief of the Tree-planting Division, with headquarters at Indian Head, Saskatchewan, has charge of the nurseries and the distribution of plants to farmers and ranchers in the three Prairie provinces. Plants suitable for the local conditions are to be put out in accordance with the instructions given by the tree-planting Promoters, who work under the Chief of the department. They inspect the proposed localities, and, if suitable, the plants are given free of charge. The tree planting Promoters inspect the sites annually until the plantations are established.

Experimental plantations of about 200 acres have been made in the reserves under the direction of the Chief of the Tree-Planting Division.

Forest Produce Laboratories are maintained by the Forest Branch, where research is carried on in timber testing, timber physics, pathology, wood preservation, and pulp and paper manufacture. Each division is under a technical chief.

The annual expenditure of the Forest Branch is approximately £150,000 (taking the £ at 5 dollars) ; receipts £16,800.

Vacancies in the staff of the Forestry Branch are filled under the direction of the Civil Service Commission. Technical foresters are required to have graduated from a recognised University course in Forestry, or to have had equivalent training and experience.

The Director of Forestry publishes an annual report, and technical bulletins contain the work of research and of other important matters connected with the forestry branch.

(2) *The Timber and Grazing Lands Branch* administers the timber, grazing and hay-making on Dominion lands outside forest reserves ; it also administers these matters in reserves where licences or permits were issued prior to the establishment of the reserves. The Dominion lands are divided into 7 districts, each in charge of a Dominion Land Agent, who is *ex-officio* Crown Timber Agent and Mining Recorder for the district. Timber on Crown lands is disposed of by this branch, by licensed birth, covering timber of all classes. No technical foresters are employed by this branch.

(3) *The Dominion Parks Branch.*—Dominion parks have been

established as national playgrounds, and they include areas wherein the scenery, fishing, hunting and historic associations are attractive to Canadian and foreign tourists. The greatest parks are situated in the mountain regions of the western provinces and smaller parks throughout the Dominion. The timber in these parks is protected by the parks branch and disposed of when desirable, so that the parks may act as forest reserves dedicated to a certain extent to timber production, fish, game and birds. In some parks, buffalo, elk, moose, deer and other animals are also preserved. During the war the average annual expenditure amounted to £60,000, and the receipts to £10,000, including £340 from the disposal of timber.

Commission of Conservation.—This Commission consists of 20 members appointed by the Governor in Council, in addition to *ex-officio* members. They hold office at pleasure. The Ministers of Agriculture, the Interior and Mines, as well as a member of each provincial Government, who is charged with the administration of the natural resources of such province, are *ex-officio* members of the Commission. The duties of the Commission are to consider questions relating to the conservation and better utilization of the natural resources of the country, to make inventories, collect and disseminate such information, conduct investigations, and frame such recommendations as seem conducive to the accomplishment of those ends. The Commission does not act in an executive capacity ; its duty is to inform and advise. The Commission is divided into a number of Committees, one of which deals with forestry assisted by an expert on the subject. Two special lines of investigation occupy the Committee, namely, the extent and character of the forest resources of the several provinces, and the study of the conditions of reproduction and growth in the pulpwood forests of Eastern Canada. The Commission publishes each year a report on the work of the year ; also special reports and a monthly bulletin entitled " Conservation."

Board of Railway Commissioners—Fire Inspection.—The Board supervises fire protection on a length of railway lines extending to 38,624 miles. Along the whole of these lines all measures necessary to prevent forest fires must be taken, such as the removal of unnecessary combustible matter, the provision of efficient spark arresters, the prohibition of dumping of fire, live

coals and ashes upon the right of way, the placing of fire guards, the establishment of special fire patrols by railway companies, the instruction by the companies of their staff relating to reporting and extinguishing of fires. The work is supervised by the field staff of the Fire Inspector's Department of the Board. The results have, on the whole, been very successful of late years.

Arrangements similar to those indicated above exist in the several provinces. They are of a very complicated nature and it is difficult to believe that the results are satisfactory.

(e) *Education.*—Complete courses leading to the degree of Bachelor of Science in Forestry are available at the University of Toronto, and at the University of New Brunswick at Fredericton. At either place the course extends over 4 years, the first two being devoted chiefly to the study of auxiliary subjects and the others to the theory and practice of forestry proper.

A School of Forestry was founded by the Quebec provincial Government in 1910, for training men for its own forest service. Subsequently the course of instruction was enlarged to a 4 years' duration leading to a Diploma.

In connection with the re-establishment of returned soldiers, a Rangers' School has been established at the University of British Columbia at Vancouver. The course lasts 5 months.

The Ontario Agricultural College at Guelph has a Forestry Department, in which instruction is given chiefly in those subjects which are of importance to owners of wood lots.

5. Private Forestry Activities.

A great number of private individuals in Eastern Canada are planting up waste lands in a small way, thus indicating that the idea of afforestation is gaining public interest and co-operation. Interest in scientific forestry has been evinced by Canadian wood-using corporations. Their trained foresters have done a considerable amount of surveying and mapping, and they have, in a preliminary and experimental way, occupied themselves with silvicultural questions. Fourteen companies, manufacturing paper and lumber in eastern Canada, have foresters in their employ, and the number would be greater, were experienced technical men available. They have done a fair amount of planting, advisory work, estimating timber, classifying land, and

experimental work. Foresters in the employ of Corporations have done similar work, as well as exploration, mapping, cruising, surveying and research. The value of working plans has been recognised by the Quebec Government, and it is hoped that they will soon be introduced.

The Canadian Forestry Association is an educational body of 11,000 members, founded in 1900, to promote public interest in the protection and development of the forest resources, the encouragement of tree planting on the prairies, and kindred objects. The Association publishes monthly the *Canadian Forestry Journal* and other educational literature bearing chiefly upon forest fire protection and silvicultural questions. It employs lecturers who move about in many parts of the Dominion. There are also numerous voluntary lecturers.

The Canadian Society of Forest Engineers aims at instructing the members in the theory and practice of forestry by discussions, and it issues publications.

6. Annual Increment and Utilization.

No statistics are available by means of which the annual increment could be estimated with any degree of accuracy. The increment measurements which have been made apply to such small areas that the data obtained are altogether insufficient to provide a basis for even a rough estimate.

The Dominion Director of Forestry states that an attempt has been made to estimate the increment of the forests in British Columbia, by placing it on an average at 100 feet board measure, or say 8 cubic feet, per acre and year. It is also stated that this estimate, if correct, cannot be used as a basis for an estimate covering the Dominion, since growth is far more vigorous in British Columbia than elsewhere in Canada. Taking, by way of illustration, the average increment throughout the Dominion forests at 5 cubic feet per acre and year, the total annual increment of the 932,416 square miles of forest would amount to about 3,000,000,000 cubic feet annually. On the other hand, the Director of Forestry states that the loss by fire, decay, insects, fungi, windfall, floods, and landslides might possibly reach 2,500,000,000 cubic feet annually, leaving a balance or net annual increment of 500,000,000 cubic feet.

The annual utilization is given as :—

Saw timber	898,769,457	cubic feet.
Pulpwood	208,118,542	,,
Total	1,106,887,999	,,

The utilization seems to be considerably more than the net increment and thus reveal a serious position.

7. Exports and Imports.

The average annual figures for the period 1910 to 1914 are :—

	Quantity, Cubic Feet.	Value, £.
Exports :		
Sawn timber	356,689,402	6,153,096
Pulpwood	102,933,337	1,282,498
Total	459,622,739	7,435,594
Imports :		
Sawn lumber	99,070,912	2,120,723
Excess of Exports.	360,551,827	5,314,871

8. Forest Industries.

Only lumbering and pulp manufacture are mentioned by the Director of Forestry, the figures given being :—

	Timber Consumed, Cubic Feet.	Value of Produce, £.	Persons Employed.
Lumbering.	898,769,457	13,958,789	34,789
Pulp manufacture	100,580,107	2,629,118	15,308
Total	999,349,564	16,587,907	50,097

SECTION III.—SUMMARY AND OUTLOOK.

In the subjoined statement a balance is drawn between production, loss, imports, exports and home consumption, in million cubic feet :—

	Saw Timber.	Pulp Wood.	Total.
Utilization	899	208	1,107
Imports	99	—	99
Total Production	998	208	1,206
Exports	357	103	460
Home Consumption	641	105	746

If these data are anywhere near the actual facts, the results would be :—

A net annual increment of about	500,000,000	cubic feet.
An annual utilization of . .	1,107,000,000	,,
An annual deficit of about .	607,000,000	,,

This deficit occurs on 932,416 square miles of forests, leading gradually to bankruptcy, unless decided steps are taken to reduce the enormous losses by fire and other causes, in fact, the introduction of a more economical management in the future. Above all, fire protection must be made more successful than it has been in the past. It is, considering the extensive area of the forests, a herculean task which the people and Government of Canada have energetically taken in hand. Still, according to all accounts, the damage is as yet very great. These fires not only prevent a sufficient regeneration of the forests, but they also destroy large masses of old timber. The local authorities have estimated that the forests contain a total of 62,500 billion cubic feet of merchantable saw timber, and 81,000 billion cubic feet of pulpwood ; that the former would last for about 70 years, and the pulpwood for 400 years. Not very many years ago it was estimated that fires alone destroyed some 10 times the quantity of timber utilized, and though fire protection has made good progress of late years, there seems to be no doubt that fires still destroy several times the quantity of utilized timber. Under these circumstances it is very doubtful whether the existing stocks of timber will meet the demands for anything like the number of years at present estimated. The demand for pulpwood has, and still is, rapidly increasing, and diligent research is going on to find a substitute for it.

All these considerations indicate the necessity of a change in the system of management, namely, the concentration of the energies of the Forest Department on the more valuable and more favourably situated parts of the forests. Steps should be taken at the earliest possible date to select a sufficient area for the establishment of " Permanent State Forests," to demarcate them, place them under special protection, and manage them for a permanently sustained yield. The longer this measure is delayed, the greater will be the difficulties. If taken in hand now there

should be no difficulty in selecting, say, 100,000 square miles of merchantable timber and pulpwood forests (including areas to be planted in the Prairie provinces), suitably distributed over the Dominion, and placing them under intensive management and working. These areas could, by managing them under well-prepared working plans, be converted into forests yielding permanently several times the quantity which the existing forests now give. In considering these suggestions it should be remembered that Canada hopes to build up a population far larger than that at present existing. Such an increase will be accompanied by a corresponding increase in the demand for forest produce. Nor should it be forgotten that the supply of coniferous wood to other parts of the earth depends to a great extent on the quantity which Canada can spare. Canada should work for an increase in the export of coniferous timber, in the same degree as such supplies in other countries decrease. After all, an area of 100,000 square miles represents only 4 per cent. of the area of Canada situated south of the 60th degree of latitude.

E. FORESTRY IN NEWFOUNDLAND.

1. General Notes.

The Dominion of Newfoundland is situated between the 46th and 52nd degree of northern latitude and the 53rd and 59th of western longitude. It has an area of 42,734 square miles and a population of 238,670 [in 1911], giving an average of under 6 inhabitants per square mile. The population consists of a white English-speaking element; the people are powerfully built, robust and hardy.

Newfoundland is a hilly country, but the highest elevation is only 2,000 feet above sea level. It has a great many inlets along the coast, so that no portion of the country is more than 60 miles from the sea. There are numerous rivers, and great potential water power is available in many places.

The climate of Newfoundland is moderately temperate as compared with the neighbouring continent of Canada.

The three principal industries of the country are fisheries, mines, and forestry. As regards the latter, the information at present available is contained in the following documents:—

(1) The reports of a Royal Commission sent to Newfoundland

in 1914 shortly after the outbreak of the war. The members of the Commission were : (1) Mr. G. E. Turner, Deputy Minister of Agriculture and Mines ; (2) Mr. R. F. Horwood, Managing Director of the Horwood Lumber Company ; (3) Mr. Vincent S. Jones, Vice-President of the Anglo-Newfoundland Development Company.

(2) A paper read by Sir Daniel Morris before the Royal Society of Arts.

(3) A memorandum by the High Commissioner of Newfoundland, presented to the Imperial Forestry Conference of 1920.

These documents deal with the same subject and, though differing somewhat in detail, they aim at the same object, namely, to set forth the importance of developing the exploitation of the Newfoundland forests, without any recommendations as to the restocking of the cleared areas.

2. The Forests of Newfoundland.

The forests are estimated to extend over about 10,000 square miles, equal to 23 per cent. of the total area. The timbered areas are generally found in the valleys of the larger rivers and their tributaries, and on the banks of lakes and ponds, in many cases consisting of strips from 1 to 2 miles wide. The forests consist chiefly of conifers with a moderate admixture of other species. The principal species are :—

(1) The *White Pine* (*Pinus Strobus*) is the most useful of the pines, but its supply has fallen off. It is said still to be found in some quantity here and there, but only scattered elsewhere. Most of it is devoted to local purposes ; it is not used for pulp manufacture.

(2) The *Red Pine* (*P. resinosa*) grows fairly plentifully, and it is largely used in the construction of vehicles and household furniture. Owing to its resinous character the timber makes excellent railway sleepers.

(3) The *Black Spruce* (*Picea muriana*) forms an appreciable proportion of the timber trees of Newfoundland and Labrador, it is considered the best material for pulp making.

(4) The *Balsam Fir* (*Abies balsamea*) is said to be abundant in the central districts. It is extensively used for pulp.

(5) The *White Spruce* (*Picea alba*) is said to be fairly abundant, but is not specially mentioned as being utilized for pulp purposes.

(6) The *Tamarack* (*Larix americana*) thrives in certain areas. It is reported to be used for schooner construction and for the flooring of buildings.

Of broad-leaved trees the following may be mentioned, some of them being used for pulp :—

(7) The *White* or *Paper Birch* (*Betula papyrifera*) grows to a good height and gives a light, strong, tough and close-grained wood.

(8) The *Yellow Birch* (*Betula lutea*) gives a close-grained, satiny timber used in the manufacture of furniture.

(9) The *Cherry Birch* (*Betula lenta*) yields a heavy, strong and hard wood used for furniture.

(10) The *Sugar Maple* (*Acer sacharum*) is found in southern Newfoundland ; it gives not only sugar but also a splendid timber with a curled and contorted grain, known as bird's-eye maple, used for cabinet work.

(11) The *Black Ash* (*Fraxinus sambucifolia*) grows to a large size in swamps and along the banks of rivers in southern Newfoundland ; its timber is coarse-grained but durable.

(12) The *American Elm* (*Ulmus americana*) is present in the island as a large tree ; it yields a heavy timber.

(13) The *Balsam Poplar* and the *Aspen* yield light timber, which may be used for pulp purposes.

Spruce and balsam fir, with a small percentage of white pine, constitute the bulk of the utilizable timber of the country. The spruce and fir grow very thickly, but not to a large size. It is stated that it does not pay to undertake logging operations of the scattered white pine and larger spruce and fir for lumber purposes as a separate operation, and that, apart from local requirements, the lumber industry for export should be combined with the simultaneous development of the pulp and paper industry, for which the spruce and fir are eminently suitable, water power being available for conversion.

3. Relationship of the State to the Forests.

Legislation.—Forest fire protection is carried out under the authority of Acts passed in 1905 and 1911. Under the former the

Governor-in-Council appoints a Chief Ranger, who appoints the wardens where necessary. Under the Act of 1911, the fire wardens are appointed by a Central Committee, which consists of the representatives of the different lumber companies and the Minister of Agriculture as Chairman. The cost of fire protection is met by Government votes and voluntary contributions of the licensees of timber limits. Mr. Horwood, in his report, states: "The loss to forest wealth to date is very slight from the use of the axe compared with the ravages of fire. Something has recently been done to check this enormous waste by the establishment of a small, poorly supported fire patrol. . . . This criminal waste of public wealth should be dealt with, for it constitutes the most serious problem in conservation. . . . The question of reproduction calls for some scientific attention as well as that of general forest conservancy."

It is prohibited by law to export unmanufactured lumber, such as pit-props or pulpwood, from Newfoundland. This law was suspended during the war, but it seems to be in force again, though not in Labrador during the next 10 years.

Administrative Methods.—The forests within 3 miles of the seashore have been reserved by the Government for the benefit of the inhabitants, who are mostly fishermen, and who make excellent woodmen during the time of the year when fishing is suspended. During the war considerable amounts of pit wood were cut in these belts for export to the United Kingdom. It is not known what area is included in these coastal forests. Practically all other forests inside the coastal belts are held under licences by private parties or by companies under the following conditions (Mr. Turner's Statement):—"The licence gives the holder the right to cut timber on the leased land for a term of 99 years on the payment of an annual rental of 2 dollars per square mile (or about 1 penny for every 7 acres), on the area conveyed under the licence. The licensee has to erect and operate a saw-mill within 3 years, of a capacity to cut at the rate of 1,000 feet board measure (83 cubic feet) for each 10 square miles of land licensed; or to spend 50,000 dollars for each 500 square miles licensed within 5 years in the erection and equipment of a building and plant for the manufacture of pulp and paper. A royalty of 50 cents. per 1,000 feet board measure is payable to the Crown on all timber

cut on the limit, except such timber as is manufactured into pulp and paper, which is not subject to a royalty." These conditions apply to all timber lands in the island, except those operated by the Anglo-Newfoundland Development Company, which holds the lands under a Charter authorised by a special Act of the Legislature.

There do not appear to be any provisions for the regeneration of the natural forests, or for the replanting of cleared areas. There is no regular Forest Authority, nor has anything been attempted for Research or for the Education of a technical staff of forest officers.

4. Annual Increment and Utilization.

No attempt has been made to estimate the annual increment. Owing to the great damage done by fires, the net increment cannot be large, until fire protection has become more efficient than it seems to be at present. For Canada it has been estimated that of the actual annual increment something like 83 per cent. is destroyed again by fire, waste in conversion and disease. Applying this to Newfoundland it is clear that the net increment is not likely to be large.

Nor is it possible to arrive at a clear idea as to the amount of the annual utilization. Some data have been given on this subject, but they are not complete. Those referring to the operations of the Anglo-Newfoundland Development Company are given by Mr. Vincent Jones as follows :—

Area held by the Company, 3,300 square miles.

Annual cut, about 4,500,000 logs, containing about 17,000,000 cubic feet quarter girth measurement, equal to 8 cubic feet per acre, or more than the net increment estimated for the forests of Canada. Out of this material, the Company obtains about 60,000,000 superficial feet of lumber, *or* 120,000 cords of pulpwood. If the Company converts the whole of the annual cut into lumber, it would pay to the State, according to the general rates :—

	$
Annual rental on 3,300 square miles . .	6,600
Royalty on 60,000,000 superficial feet lumber at 50 cents. per 1,000	30,000
Total	36,600

which comes to about 1 cent per 4·65 cubic feet ; in other words, the Company pays about a halfpenny for every cubic foot of timber taken out of the forest. If the whole of the cut is used as pulp-wood, the Company pays to the State no royalty and only 6,600 dollars rent, so that it would pay 1 penny for every 12 cubic feet of timber, quarter-girth measurement, taken out of the forest.* In case the Company should pay, under its Charter, at rates differing from the rates paid by other licensees, the above figures would require modifications accordingly.

5. Exports and Imports.

The above-mentioned Forestry Commission give the following data for 1909—1912 :—

Annual Export of Timber . .	306,440	cubic feet.
Annual Import of Timber . .	136,040	,,
Excess of Exports over Imports.	170,400	,,

The exports of paper and pulp were as follows :—

	Paper, Tons.	Pulp, Tons.
1910 . .	7,900	6,900
1911 . .	21,100	27,200
1912 . .	26,800	48,400
1913 . .	44,400	57,500

While the export of timber had considerably decreased before the war, the export of paper and pulp had rapidly increased.

6. Summary and Outlook.

It is not possible, with the information at present available, to prepare a proper balance-sheet of increment, utilization, consumption, export and import. Only a very rough estimate can be made, somewhat on the following lines :—

Mr. Horwood, in his report, estimates the average contents per acre of wooded land at 10 cords of pulpwood and 1,000 superficial feet of lumber, which together represent about 800 cubic feet solid of quarter-girth measurement. If the forests are worked like those of the Anglo-Newfoundland Development Company, that is to say, at the rate of 8 cubic feet per acre all round, the

* The same rate applied to coal would give to the proprietor of the mine about 4 pence royalty per ton of coal raised.

present stock would be sufficient for 100 years, and if reproduction were to replace the annual cuttings, the present system of working might go on for ever. The "if" is, however, a powerful one. In the first place, Mr. Vincent Jones stated distinctly in his report that the black spruce, the most important pulpwood tree, grows comparatively slowly. In the second place, fire has, in the past, destroyed several times as much as has been taken out by cutting, and, unless fire protection is more effective than it has been up-to-date, the existing stock may come to an end very much sooner than in 100 years. In the third place, the demand may, and is most likely to, increase as time goes on. If it were to double and fires to go on, the out-turn could be kept up for a moderate number of years only. The requirements of the United States are constantly increasing, and it is more than doubtful whether the States around the Baltic will be able to supply the United Kingdom with 6 million loads of timber annually, as they did before the war.

Most undoubtedly the Government of Newfoundland should bestir itself without loss of time. It cannot, it is feared, cancel now the licences by which it alienated the forests for a period of 99 years, but it should do what is now possible in the following directions :—

(1) To watch and control the work in the forests, and to resume all areas the holders of which fail to comply with the conditions laid down in the licences.

(2) To organise a really efficient system of fire protection.

(3) To assist the natural regeneration of all areas which are still in a condition to answer suitable silvicultural measures, and to replant or sow up all areas which are below that condition.

(4) To secure without delay the services of an efficient Forestry Expert as head of the Forest Department with an adequate staff to carry out the forest policy of the Dominion in the above and other directions, such as a survey of the resources of the forests, the rate of growth, the local consumption, and the early preparation of a balance sheet of increment, utilization, exports, imports and consumption.

The execution of such a programme will, no doubt, cost money,

and it is much to be regretted that the Government has alienated this great national wealth for so long a period and for such inadequate payments, as indicated above. The Government has, apparently, done this in the desire to develop the working of the forests and thereby provide work for the population during times of the year when the fishing is slack. This was, no doubt, a laudable object, but it could have been obtained at a less disastrous sacrifice. There can be no excuse for extending the licences over so long a period as 99 years, and though the rates of rent and royalty had to be low for a number of years, it should have been recognised that those actually fixed are so low that this valuable State property has practically been given away for almost nothing. Unless the working of the licences permits an enhancement of the rates, future payments for forest conservancy measures will represent the penalty which the State will have to meet to make up for the want of foresight on the part of past Governments.

The above notes do not apply to Labrador, the available information for which is too meagre to permit of a description of the forestry question in that part of the Dominion.

F. FORESTRY IN THE UNION OF SOUTH AFRICA.

(No. 12 on Map).

SECTION I.—SHORT DESCRIPTION OF THE COUNTRY.

The Union consists at present of four States, which are situated between the 22nd and 35th degrees of southern latitude and the 17th and 33rd degrees of eastern longitude. Their areas and population are as follows :—

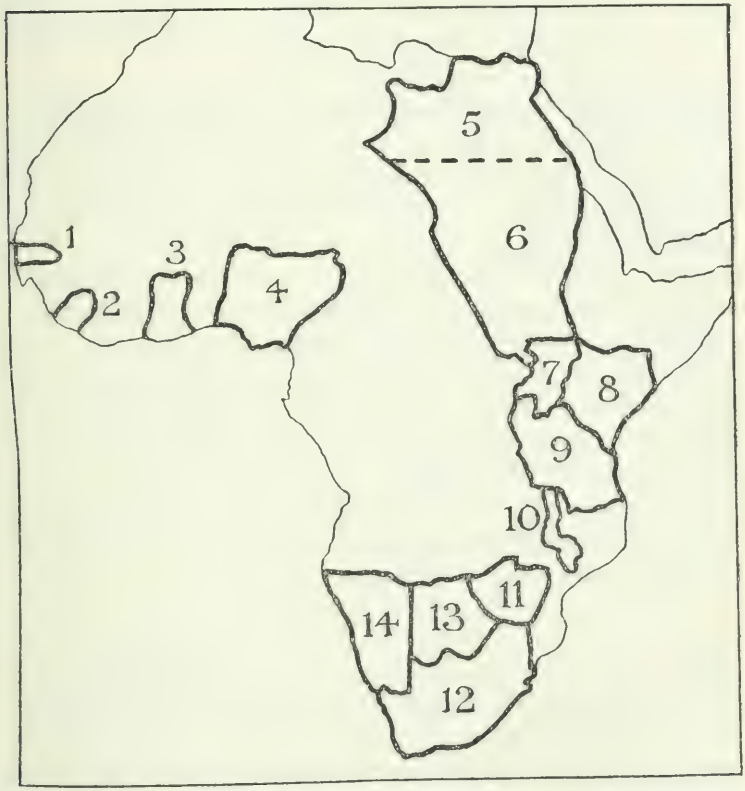
Name of State.	Area, Square Miles.	Population in 1911. Total.	Per Square Mile.
Cape Colony	276,995	2,565,000	9
Natal	35,371	1,194,000	34
Orange Free State	50,392	528,000	10
Transvaal	110,426	1,686,000	15
The Union	473,184	5,973,000	13

The population had increased during the previous 7 years by 15 per cent., and it was expected that it would be doubled in about 50 years. Of the population only 1,276,000 were Europeans

about one-half British and the other half Dutch. Four-fifths of the people were coloured.

South-West Africa, lately a German Colony, has now been

FIG. 9.



Sketch Map of Africa showing the position of the several Colonies and Protectorates.

1. Gambia.
2. Sierra Leone.
3. The Gold Coast.
4. Nigeria.
5. Egypt.
6. The Sudan.
7. Uganda.
8. Kenya.
9. Tanganyika.
10. Nyasaland.
11. Southern Rhodesia.
12. Union of South Africa.
13. Bechuanaland.
14. South-West Africa.

added to the Union, but the information regarding it is not sufficient to deal with it in this place.

1. TOPOGRAPHY.

The Union territory consists of three main regions :—

(1) A strip of low land lying along the sea coast from the mouth

of the Orange river to northern Zululand. It varies in width from a mile or two to 30 and even more miles.

(2) A range of hilly ground rising by degrees behind the coastal strip. Near Capetown the hills are quite close to the sea; on going inland they become higher, till they reach heights of 3,000 to 4,000 feet at a distance of 30 to 40 miles from the sea, and from 5,000 to 6,000 feet at 60 miles. These hills, intersected by valleys, are the spurs of a long range of mountains running from Capetown to the Zambesi valley. The height ranges from 3,000 to 7,000 feet, and in Basutoland as much as 11,000 feet are reached. Geographers call these hills the "Drakenberg or Quathlamba Range."

(3) Behind the Quathlamba range the country spreads out into a vast tableland, partly flat, partly undulating, sometimes intersected by ridges of rocky hills, forming the third region. Its height above sea varies from 3,000 to 5,000 feet, and some of the hills reach 6,000 feet. Thus the Quathlamba range may be regarded as the escarpment of the tableland. The latter occupies seven-eighths of South Africa.

There are no rivers in the true sense, since the rivers usually contain little water during three-fourths of the year; nor are there any lakes of any importance.

2. Geology and Soil.

There seems to be much uncertainty on some of the main points in the geological record of South Africa, in the determination of the relative age of the more ancient sediments and of the great intrusion of granite rock in them. However, geological formations do not appear to have any great influence in determining the distribution of the forests, which occur with little change in their general character on different formations.

Generally, the soils in forest areas are poor in plant food, especially in lime and phosphoric acid. The soils most suitable for afforestation are those derived from granites, table mountain sandstone and dolorites. The soils of South Africa are generally not characterised by any great depth, although hillside soils in Natal are good in this respect so that their physical properties are excellent. On account of the long, dry season, depth of soil is of great importance, and is one of the important points to be

considered in selecting areas for planting. Hard pan occurs over large areas which should be avoided, and so should stiff black clay soils. In the forest zones, much soil is sour and requires thorough working before it can be planted, making planting expensive.

3. Climate.

Owing to a combination of latitude and topography, the temperature is remarkably even throughout the Union. The mean annual temperature of Capetown is 62 degrees Fahr., and that of Pretoria, 1,000 miles north of it, is 63·5. The mean annual range differs from 12 degrees on the south coast to 28 degrees on the Transvaal plateau. The extreme shade temperature on record is 125 degrees in January, and 6 degrees in June. Frosts are practically unknown on the coast, but occur in the interior. Especially early frosts are doing damage to plantations on the higher parts of the country. Indigenous forests are only rarely touched by frost, and then the damage is generally of a trivial character.

The rainfall in the different parts of the Union differs very much, both as regards the quantity and the time of year during which it falls. In the western and south-western coastal district most of the precipitations occur during winter; the rest of the Union is essentially a summer rainfall area, the weather during April to September being practically dry. Generally the rainfall increases from west to east, and is greatest along the mountain ranges of the south, south-east and east forming the great escarpment. The indigenous forests follow the rainfall and are thus found along the coastal belt on the seaward slopes of the escarpment from the Cape Peninsula to the Zoutpansberg mountains. They seldom occupy any extensive area continuously, but are almost always found in isolated patches, from a few to a few thousand acres, in the kloofs or ravines and facing south or south-east. In the interior also the rainfall becomes heavier on going east. Thus, in the western part of the Orange Free State and the Transvaal, the average annual fall is about 17 inches which increases in the eastern Orange Free State to about 28 inches, and in the eastern Transvaal to about 38 inches. The western and central interior part of the Cape province is very dry,

the rainfall being from 5 to 15 inches, and tree growth is absent except along river banks. Hail is frequent and often causes severe damage to forests.

SECTION II.—THE FORESTS OF SOUTH AFRICA.

1. Areas and Ownership.

The division of the Union land is as follows :—

	Area in Square Miles.	Per cent. of Total Area.
Agricultural land. .	20,928 ..	4·4
Forests . . .	2,361 ..	0·5
Other land . . .	449,807 ..	95·1
Total . .	473,096 ..	100·0

Agricultural land includes only the areas under agricultural crops and fruit and the areas lying fallow in 1918, while the areas under pasturage and waste lands are included under " Other Lands." It has not been possible to split up the forest area under " Merchantable " and " Unprofitable or Inaccessible." The total forest area, however, does not include the wooded area of Native locations and reserves.

The ownership of the forests is as follows :—

	Square Miles.	Per cent. of Total Forest Area.
State forests . . .	880 ..	37·3
Corporation forests . .	35 ..	1·5
Private forests. . .	1,446 ..	61·2
Total .	2,361 ..	100·0

The above areas actually carry trees. In addition, the Forest Department holds an area of about 2,430 square miles which is treeless but serves as a protection of the head waters of streams.

Of the 3,310 square miles comprising the State forest reserves, 77 per cent. are demarcated and 23 per cent. undemarcated. Forest land once demarcated cannot be alienated without the consent of Parliament.

2. Types of Forest Growth.

South African Foresters distinguish four types of woodland vegetation : forest, scrub, bush-veld, and palm-veld.

(1) *Forest.*—Vegetation of the woodland type occupies a very small portion of South Africa. It occurs in the Knysna and Humansdorp districts of the Cape, also elsewhere in smaller areas. These forests are generally confined to the kloofs, steep valleys and flanks of the mountains facing the sea. They are mostly evergreen, the principal species being: The Yellowwoods (*Podocarpus Thunbergii*, *elongata* and *falcata*); the Sneezewood (*Ptaeroxylon utile*); the Stinkwood (*Ocotea bullata*); the Black Ironwood (*Olea laurifolia*); Lemonwood (*Xymalos monospora*); the White Ironwood (*Toddalia lanceolata*); Candlewood (*Pterocelastrus variabilis*); the Assegai Wood (*Curtisia faginea*); White Pear (*Apodytes dimidiata*); the Saffron (*Elæodendron croceum*); Wild Elder (*Nuxia floribunda*); the Cape Box (*Buxus Mac-Owani*), and many others.

There are also a considerable number of shrubs between the trees. Lianes and epiphytes are plentiful. In the forests near Clanwilliam the Clanwilliam Cypress (*Widdringtonia juniperoides*) (*Callitris arborea*) occurs.

(2) *Scrub.*—It is a marked feature of the south-western coast region of the Cape. The leaves of the plants are, as a rule, small and leathery. The dominant shrubs and plants belong to the *Proteaceæ*, *Ericaceæ*, *Restionaceæ*, *Thymelæaceæ*, *Penæaceæ*, *Grubbiaceæ*, *Rutaceæ*, *Brunniaceæ* and *Ficoideæ*.

(3) *Bushveld.*—This woodland vegetation occurs in the extreme north-west corner of the Union territory, and also on a much larger scale in the north-east. It generally bears a parklike appearance. The prominent trees in the western part are *Acacia albida*, *A. Karroo*, *A. giraffæ*, *Combretum primigenum*, *Euclea pseudebenus*, *Tamarix austroafricana*, and *Ziziphus mucronatus*. The southern edge of the Transvaal bushveld is composed of *Acacias*, *Combretum veld*, *Rhus lancea* and *Faurea saligna*. Further north appear *Parinarium mobola*, *Pterocarpus erinaceus*, *Zyzygium cordatum*, *Kigelia pinnata* and *Trichilia emetica*. Along the northern boundary of the Transvaal *Baobab* (*Adansonia digitata*), *Acacia pallens*, *Combretum porphyrolepis* and *Bolusanthus speciosus* are plentiful.

(4) *Palm veld.*—This woodland vegetation comprises a narrow littoral strip extending from East London to the northern limit of the Union. Its characteristic is the presence of palms, such as

Phœnix reclinata and *Hyphæne crinita*. *Mimusops caffra* is dominant in the southern part, and there are various species of *Aloe* and *Euphorbia*. The northern portion of this area is more tropical in character, presenting dense bush and swamp forests of mangroves composed of *Avicennia officinalis*, *Rhizophora mucronata*, *Bruguiera gymnorhiza*, *Ceriops candolliana*, with *Raphia vinifera*. The coconut palm (*Cocos nucifera*) is often a dominant feature of the landscape.

3. Prominent Timbers and other Produce.

Timbers.

(1) The Yellowwoods are large trees of the first economic importance up to 120 feet high with little taper, a superior substitute for imported pine. The timber is rather harder and heavier than the latter, stronger, and of better appearance; used for a great variety of purposes. It is the most abundant species in the forests, but it has been heavily cut.

(2) Stinkwood is a large evergreen tree up to 90 feet high and 5 feet diameter; of first economic importance. Wood, heavy, hard, very strong and durable in contact with the soil. Used for a great variety of purposes, but the supply is limited.

(3) Assegai, a smaller tree, up to 60 feet high, 1½ feet diameter. Wood very hard, heavy, moderately strong. Used principally as a waggon wood. Supply limited.

(4) Black Ironwood is a large tree up to 90 feet high. Wood very hard, heavy and strong. Used for waggon work, piles, bridges, telegraph poles, and railway sleepers. Supply rather limited.

(5) White Pear, an important tree, up to 70 feet high. Best wood for felloes in waggon construction.

(6) Sneezewood, a small tree up to 50 feet high. Wood very strong, permeated with an oily substance which makes it very durable in contact with the ground. White ant and Teredo resistant.

(7) Cape Box, small tree up to 20 feet high. Exported to Britain and used in place of *Buxus sempervirens*.

Other Produce.

(1) Wattle Bark, obtained from *Acacia decurrens var. mollis*, introduced from Australia about 50 years ago. To-day about

312,000 acres are under wattle, of which about 240,000 acres are in Natal. Large quantities of this tanning bark are exported either chopped up or as an extract ; 62,000 tons in 1919.

(2) Buchu, used for medicinal purposes, consists of the dried leaves of several species of *Barosma*, shrubs which grow on the mountains in the south-west of Cape Colony. The most valuable kind is *B. betulina*. Export in 1919 amounted to 67 tons.

4. Relationship of the State to the Forests.

Legislation.—The existing forest legislation is contained in the Union Forest Act, No. 16 of 1913 and its amending Act, No. 14 of 1917. The former Act was designed to consolidate and amend the forest laws previously in force in the four provinces of the Union and relates to forest tenure, forest demarcation, the regulation and protection of forests, etc. There are demarcated and undemarcated reserves. Demarcated reserves cannot be alienated except with the consent of both houses of Parliament. The Act gives the power of expropriation for forestry purposes and provides that no new rights can spring up by prescription in forest estates. Private proprietors can have all or any of the provisions of the Act applied to their forests. The Act also provides for hunting and fishing in forests. Act No. 14 of 1917 merely strengthens the principal Act in respect of demarcations undertaken before 1913.

Administrative Methods.—(a) *Fire Protection.*—Clean fire traces are maintained around indigenous and artificial woods, and these are periodically ploughed up, hoed, or burnt off. The planting of Acacias around the areas has not been found as effective as maintaining clear traces. Owing to the evergreen character of the indigenous forests and the moist condition usually associated with the forest floor, internal fires are very rare. In plantations however, in addition to external traces, internal belts are either left unplanted and kept clear, or planted with less inflammable species, such as belts or lines of Eucalyptus in pines, the litter being swept up over 5 feet on either side of the belts. The forests and plantations are regularly patrolled.

(b) *Regeneration of Natural Forests.*—The indigenous forests are worked on the selection system. In some of them, especially in the east, natural regeneration is very deficient, but in others, as

in the Knysna and Transkeian forests, it is more abundant. In the majority of the forests, the conditions for favourable regeneration are not good, owing to faulty treatment in the past. Almost all the species are said to be of slow growth, and a long time must elapse before much mature timber from them will again become available. The silvicultural requirements of the species are as yet imperfectly understood, and, if the yield is to be improved, much more time, attention and money must be devoted to the subject than has been the case in the past.

(c) *Roads and Paths.*—Many of the forests are already linked up with public roads, but a great deal remains to be done in this direction. Bridle and inspection paths are more numerous, and there is hardly a forest which is not intersected with them.

(d) *Planting Waste Areas.*—Owing to the very restricted natural forest resources of the Union and the great need of augmenting the timber supplies, afforestation of vacant waste lands is the main channel along which the activities of the Department are directed. Numerous exotic species are employed, those yielding the ordinary softwoods of commerce and durable hardwoods, such as some of the Eucalypts, the selection differing in various parts of the country according to the factors of the localities.

It has been estimated that it will be necessary to plant 300,000 acres with conifers if the country is to become independent of imports. Up to March 31st, 1918, the following areas had been planted :—

Forest Department plantations .	51,104 acres.
Railway sleeper plantations . .	23,225 ,,
Added since then	21,837 ,,
Total up to 1921 . .	96,166 ,,

Of the older plantations a considerable proportion were of an experimental nature ; others will serve only to supply fuel, poles and rough farm materials ; others have not been successful. Allowing for these matters, some 20,000 acres of the older plantation must be deducted as far as the supply of timber in the future is concerned.

(e) *State Assistance given to Forestry.*—The Forest Department disposes of plants and seeds of forest trees at very low rates, upwards of 5 million transplants having been sold in one year.

Most of these were planted in the Transvaal and Orange Free State on the treeless high veld.

The Department is always ready to give advice without charge, as to the selection of species, methods of cultivation, valuation of plantations, &c. The Department's officers also give lectures on forestry questions.

The Government Land Bank of the Union advances money to farmers for planting at 5 per cent., for 30 years. Tree planting competitions are held under the auspices of the Natal Agricultural Union and the Natal Royal Agricultural Society. The scheme is being continued by the Union Government. The result of these competitions up to date has been the planting of 2,115 acres.

Forests and plantations are taxed at the same rate as land without trees on it; that is to say, the forest or plantation, as such, bears no burden beyond the ordinary land tax.

(f) *The Forest Authority.*—The Department is controlled by the Chief Conservator; it is a branch of the Department of Agriculture. The Union is divided into 7 conservancies, each presided over by a Conservator of Forests. Each conservancy is divided into a number of districts. The number of District Forest Officers is at present 25, but a considerable increase is under consideration. Each district comprises a number of forest stations or patrols in charge of foresters.

Attached to the office of the Chief Conservator are 3 forest officers who devote their time to research and technical matters.

(g) *Education.*—No forest school for the instruction of members of the superior staff exists in the Union, as the number of recruits is only one or two a year. Such officers are recruited, as far as possible, from South African students who have obtained the degrees or diplomas of recognised European or American forest schools.

The subordinate staff is recruited from South African youths who have served a satisfactory apprenticeship at a forest station and thereafter passed through the school for foresters and forest apprentices conducted by the District Forest Officer at Tokai, Cape Peninsula, who is guided by, and directly responsible to, the Chief Conservator of Forests. The course comprises 1 year and 9 months.

(h) *Research.*—The Department has as yet no laboratories for research, and mycological, entomological and chemical work has

in the past been done by officers of the Department of Agriculture. The advantage of such work being done by forest officers has been recognised, and it is hoped shortly to have departmental laboratories. Botanical research is undertaken by the professional Assistant of the Chief Conservator. An expert is investigating the properties and qualities of South African timbers and the best methods of handling and seasoning them.

(i) *Experimental Work.*—During the existence of the Department a great deal of valuable experimental field work has been done, and the present silvicultural practice of the Union has been largely moulded by it. This refers, more particularly, to the nursery practice, the methods of planting and direct sowing, the planting distance best suited to different species, the most suitable mixtures of species, the most appropriate degrees of thinning, and above all, the selection of suitable species for planting in the different parts of the Union. In the past the experimental work was largely the result of individual action. Now all this work has been placed on a systematic basis, so as to secure the publication of results, and to make them generally useful.

(j) *Income and Expenditure.*—The average annual income and expenditure for the 3 financial years 1916—1919 were as follows :—

	Forest Department.	Railway Plantations.	Total.
	£	£	£
Income . . .	71,355	7,199	78,554
Expenditure . .	129,515	25,750	155,265
Deficit . . .	58,160	18,551	76,711
Cost of Plantations only	64,118	23,029	87,147

The cost of the plantations is, in reality, a capital expenditure. Allowing for this, it will be seen that there is really a surplus of £10,436. The older plantations have commenced to give a return, and, judging by the results so far obtained, there seems to be no doubt that the plantations will be a financially successful undertaking, apart from the fact that the country will have been made independent of foreign supplies.

5. Private Forestry Activity.

The importance of tree planting has been recognised as early as the seventeenth century. It is on record that in 1679 one of

the early Governors urged his burgher councillors to plant oaks and other kinds of trees. South Africa owes to the early Dutch settlers the introduction of such trees as the Stone pine (*P. pinea*), the Cluster pine (*P. maritima*), the oak and the poplar. In order to improve their properties, millions of trees are planted annually by private individuals. Many municipalities have initiated afforestation schemes, of greater or lesser extent, on commercial lines, and practically all have devoted some attention to the planting of street and roadside trees as a means of improving the local amenities. The gold mining companies on the Rand have established plantations of their own as near to the mines as possible, and to-day the country all along the Rand, once devoid of trees, is fairly well wooded. The black wattle industry is essentially in the hands of private individuals and companies, and the success that has met their efforts is proved by the prosperity of the industry they have built up.

Many societies are interested in forestry and the timber supply of the country, and the Department never lacks their support. Public opinion strongly favours a forward movement in afforestation as soon as an adequate, trained staff has been secured.

6. Increment and Utilization.

The Increment has been estimated as follows :—

	Indigenous Forests.		Plantations.		Total.	
	Area, Square Miles.	Increment, Cubic Feet.	Area, Square Miles.	Increment, Cubic Feet.	Area, Square Miles.	Increment, Cubic Feet.
State Forests .	764	15,157,760	116	11,136,000	880	26,293,760
Other Forests .	759	9,715,200	722	60,312,000	1,481	70,027,200
Total . .	1,523	24,872,960	838	71,448,000	2,361	96,320,960

In the above table the increment per acre of plantation has been placed at 150 cubic feet, that of indigenous State forests at 31 cubic feet, and for other forests at 20 cubic feet. These estimates are believed to be fairly accurate. The data represent gross increments, as the local authorities did not feel able to estimate the loss by fire, waste, &c. It is, however, stated that the loss by fire is very small and probably not more than 1 per cent., that waste in plantations is small, but that in the indigenous

forests is likely to be high. On the whole, a deduction of 20 per cent. seems fully adequate, leaving a net increment of 77,000,000 cubic feet.

The Annual Utilization is estimated as follows :—

	Indigenous Forests.	Plantations.	Total.
Timber, C. Feet :			
State Forests .	960,898 ..	661,858 ..	1,622,756
Other Forests .	12,117,100 ..	6,063,400 ..	18,180,500
Total Timber.	13,077,998 ..	6,725,258 ..	19,803,256
Fuel, C. Feet :			
State Forests .	1,806,145 ..	1,561,768 ..	3,367,913
Other Forests .	2,800,335 ..	39,970,376 ..	42,770,711
Total Fuel .	4,606,480 ..	41,532,144 ..	46,138,624
Timber and Fuel .	17,684,478 ..	48,257,402 ..	65,941,880

It will be observed that the utilization of home-grown wood is about 11 million cubic feet less than the estimated net increment. This is, however, neutralised by the fact that until now about one-half of the 40 million cubic feet obtained by the cutting of bark wattles is not utilized for want of demand, and thus left rotting on the ground.

7. Exports and Imports.

The data given in the " Statement " are incomplete ; they are as follows :—

	Quantity, Cubic Feet.	Value, £.
Exports :		
Unmanufactured . . .	? ..	3,300
Manufactured . . .	? ..	5,700
Total Exports . . .	? ..	9,000
Imports :		
Unmanufactured . . .	15,618,000 ..	980,800
Manufactured . . .	3,882,000 ..	577,700
Total Imports . . .	19,500,000 ..	1,558,500
Excess of Imports over Exports	? ..	1,549,500

About two-thirds of the imported unmanufactured timber came from Scandinavia and the rest from the United States, Australia (Eucalyptus) and India (Teak). The manufactured timber came chiefly from Scandinavia.

8. Forest Industries.

The principal branches of industry are, approximately, the following :—

	Value of Material, £.	Value of Produce, £.	Persons Employed.
Working in wood generally	830,469	1,294,683	4,256
Vehicle construction	313,947	694,846	3,018
Ship and boat-building	20,100	46,129	145
Furniture manufacture	352,053	757,163	2,235
Total	1,516,569	2,792,821	9,654

9. Summary and Outlook.

In the following statement a balance is drawn between utilization, export, import consumption and increment :—

	Cubic Feet.
Utilization	65,941,880
Add Imports	19,500,000
Total	85,441,880
Deduct Exports (Estimate)	77,000
Total Consumption	85,364,880
Net Increment (Estimated)	77,000,000
Excess of Consumption over Increment	8,364,880

The number of cubic feet (77,000) exported has been estimated from the value of the exports (£9,000) by assuming that the value per cubic foot exported is the same as the value per cubic foot of the imported timber.

For some years to come the excess of consumption over increment will, however, in reality be greater than appears from the above balance sheet, because three-fourths of the present increment is laid on by plantations, most of which are as yet too young to give a return. By continuing the system of planting the deficiency should disappear after a limited number of years.

when the country will be independent of imports, with the exception of limited quantities of timber which cannot be grown in South Africa. The extent of future planting should take into consideration the probable increase of population.

Next to India, South Africa was the first of the British Colonies to devise and execute a rational forest policy. Finding the area of indigenous forests altogether insufficient to supply the country with timber and firewood, and being poor in workable coal seams, the Government of Cape Colony started plantations in 1876 at Worcester, consisting of Blue Gum (*Eucalyptus Globulus*). Many others followed, consisting of a variety of exotic species, being under the impression that the indigenous species were too slow growing and, in some cases, too difficult to rear. The three main classes of plantations are pine plantations for light woods, Eucalyptus for timber, and Wattles for tanning bark. The principal pine species are *P. insignis*, *P. maritima* and the Canary Island pine. Of late years some Mexican conifers have been tried to suit changes in the local conditions of the several parts of the Union.

Much as the general policy is to be approved, there is one point for serious consideration, and that is the neglect of the indigenous species, more particularly of the Yellowwoods. These woods (*Podocarpus spp.*) yield excellent timber, superior to the introduced pine species, but it is reported that they are difficult to rear, owing to their requiring protection while young. In the indigenous forests they reach a height up to 120 feet, and they are healthy. On the other hand, the cluster and insignis pines are already liable to disease, and it has been suggested to replace them in certain parts of the Union by the Himalayan Chir pine (*P. longifolia*), and perhaps by Canary pine, or Mexican conifers. It would, however, appear that the failure in rearing the Yellowwood might be overcome by planting it in the existing bush or scrub, so that the latter may provide the necessary shelter to the young plants and to be cut away when the Yellowwood does not require any further protection. This method has been extensively used with success in Europe in converting coppice woods into high forests, and there does not seem to be any reason why it should not be successful in South Africa. Indigenous species are less likely to fall victims to disease than exotic species.

G. FORESTRY IN THE COMMONWEALTH OF AUSTRALIA.

SECTION I.—THE COMMONWEALTH GENERALLY.

The Commonwealth consists of the following States :—

Name of State.	Area, Square Miles.	Population in 1911. Total.	Average per Square Mile.
Queensland	670,500	605,813	0·9
New South Wales	309,432	1,646,734	5·3
Victoria	87,884	1,315,551	15·0
South Australia	380,070	408,558	1·1
Western Australia	975,920	282,114	0·3
North Territory	523,620	3,310	0·006
Tasmania	26,215	191,211	7·3
Federal Territory	940	1,714	1·8
The Commonwealth	2,974,581	4,455,005	1·5

The mainland of Australia lies between the 10th and 39th degree of southern latitude, about one-half of the country being situated in the tropics. Tasmania lies between the 41st and 44th degree of latitude.

The population of the Commonwealth is practically all white, and efforts are being made to keep it so ; whether this will succeed, is another question.

Without going into the details of the establishment of the Australian Colonies, it may be stated that all, except Western Australia, were granted responsible government in 1855. Western Australia receiving it in 1890. The constitutions of the several States, while marked by minor differences, are all upon the same model, with legislative assemblies and legislative councils. The Commonwealth of Australia was inaugurated on January 1st, 1901. Under its constitution the States retain all the powers which belong to them as self-governing communities, except those which they have surrendered to the Commonwealth, such as defence, tariffs, and postal matters. Trade between all the States is free. Each State manages its forests independently of the Commonwealth authorities.

1. Topography.

At a moderate distance from the east coast the Great Dividing Range runs from the northern part of Queensland through New South Wales to Victoria, when it sweeps round to the west in the direction of South Australia. In Queensland the Dividing Range is of moderate elevation, from 3,000 to 5,000 feet at the southern

Fig. 10.

Sketch Map showing the Positions of the several Australian States.

1. Queensland.
2. New South Wales.
3. Victoria.
4. South Australia.
5. West Australia.
6. Northern Territory.
7. Tasmania.

boundary. In New South Wales it is more elevated, reaching near the Victorian boundary its greatest height, 7,300 feet, Excepting a belt of low land along the coast the country between the sea and the dividing range consists of broken ground presenting a series of interrupted plateaux between which numerous short streams find their way to the sea. On the west of the dividing range the ground descends much more gradually,

forming elevated plateaux, drained in the southern part by the Murray river and its tributaries, and in the northern part by the Eyre river system, down to an elevation of less than 500 feet.

In South Australia the greater part of the land lies at a low elevation, the principal hills being the Mount Lofty Range near the Gulf of St. Vincent (1,000 to 2,000 feet) and the Flinders Ranges, east of the Gulf of Spencer (1,000 to 3,000 feet). Proceeding to Western Australia, the belt of low land near the sea runs along the south and west coasts of that State, and also the whole of the north coast. In the south-western part of Western Australia the land soon rises on going east to a plateau of an average elevation of about 800 feet, which bears the main timber wealth of that State.

The central part of Australia consists practically of a quasi-desert extending over some 1½ million square miles, the general elevation being between 1,000 and 2,000 feet, with isolated parts rising to 3,000 and even 4,000 feet. The information as regards the northern half of Australia, the tropical part, is at present deficient, with the exception of that portion which is situated in Queensland.

The island of Tasmania may be said to be a continuation of the eastern Dividing Range, separated from it by a submerged part. It is throughout a hilly country, the highest part reaching an elevation of just over 5,000 feet.

2. Climate.

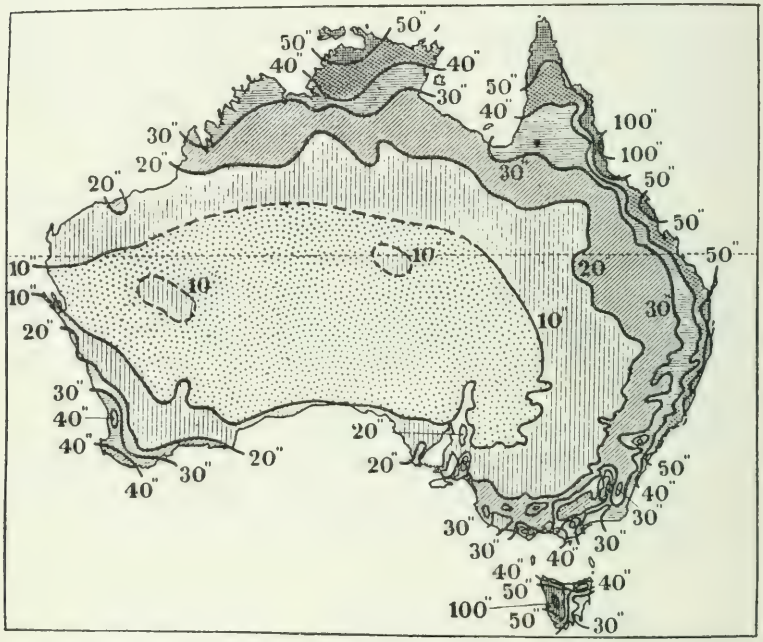
The mean annual temperature in the coastal belt is moderate; the following data being given:—Brisbane, 69, Sydney 63, Melbourne 57, Adelaide 65, Perth 64, and Hobart 54 degrees. The temperature in the interior is much higher; it is stated to rise to 130 degrees during the summer.

The rainfall differs very much. It is heaviest on the north-east coast, reaching 145 inches at one place, and heavy along the coast belt in the east, south-east and south-west (30 to 50 inches). It diminishes rapidly on going inland, and reaches its minimum in the neighbourhood of Lake Eyre, in the centre of the mainland, with only 5 inches. There are regular zones of rainfall from the

coast inland. On the whole it may be said that these zones comprise the following areas :—

Under 10 inches rainfall.	.	1,105,452 square miles.
From 10 to 20 inches rainfall .		943,431 ,,
From 20 to 30 inches rainfall .		530,558 ,,
From 30 to 40 inches rainfall .		210,621 ,,
Over 40 inches	. . .	190,489 ,,

Fig. 11.



Mean Annual Rainfall.

(From the Oxford Survey of the British Empire.)

In a general way it may be said that all land which has a rainfall of 10 inches and over in the year (and in some cases even less) is useful for pasturage, while areas with more than 20 inches are sufficiently watered for all purposes. The latter include practically the whole of the coastal areas and the Island of Tasmania with the exception of parts of the coastal area of South Australia and the north-western part of Western Australia.

3. Agricultural Pursuits and Industries.

Australia is at present primarily a pastoral country. New South Wales leads the way in the number of sheep, while Queensland occupies first place with regard to cattle. The latter are bred principally for beef in the Northern Territory and in Queensland, but Victoria has more milking cows than Queensland. Dairying is making great strides throughout the Commonwealth. Both sheep and cattle suffered severely from the drought of 1902—1903, when their numbers were greatly reduced, in the case of sheep from 98 million to 53½ millions. By 1910, however, the loss had been made good. In that year the exports of Australian wool were valued at 28 million pounds sterling. Next in importance to wool comes the export of frozen mutton and lamb. It was begun in 1879 on a small scale, and it has now reached large proportions.

Second in importance to sheep farming is the cultivation of wheat, which is grown in all the States. They all export wheat now with the exception of Tasmania and possibly Queensland. The harvest of 1911—1912, the largest on record, yielded 95,100,000 bushels from 7,370,000 acres. A rainfall as low as 16 inches on light soil gives paying crops of hard wheat. In Western Australia, where the rainfall is regular, even an annual rainfall of 12 to 14 inches suffices.

Numerous other crops are grown, but on smaller areas than wheat, such as oats, maize, green fodder plants, potatoes, sugar-cane, barley, rye, flax, fruits of many varieties, grapes for wines &c. The total area under crops has risen from 188,000 acres in 1860—1861 to 18,528,000 in 1915—1916; since then a temporary falling off has occurred, due to the war.

Coal was the first mineral discovered in Australia. New South Wales provides nine-tenths of the total output, but seams have been opened in every State. Gold was first found in 1851 in New South Wales, then in Victoria and finally in all States. Copper is available in immensely rich deposits. Silver, silver-lead, and also zinc are obtained from the Broken Hill mines in New South Wales. Tin is mined in all the States. Extensive iron deposits are available in New South Wales, Queensland, South Australia, Western Australia and Tasmania.

Indirectly it is due to the discovery of gold in Australia that the

manufacturing industry has now grown to such large dimensions in the Commonwealth. When the alluvial gold mines began to fail, the surplus labour took partly to agriculture and partly to manufacturing. At present New South Wales and Victoria do the bulk of the manufacturing work of Australia.

4. The Forests.

The valuable forests of Australia are stocked principally with Eucalypts and Wattles; they are found in the coast belt with a rainfall of 20 inches and over. That belt is estimated to contain about 860,000 square miles, of which about one-half is situated in tropical Australia. The forest area in the belt is estimated at about 138,660 square miles. On proceeding from the coastal belt towards the interior, the quality of the forest diminishes rapidly; still, there are enormous areas stocked with an inferior class of forest which is very useful for local consumption, although it does not affect at present the general question of the timber supply of the country.

It is stated that the forest area in the coast belt was formerly much larger than it is now, that a great part of the forest had to make way for settlement, and that great damage was done by forest fires, which destroyed considerable areas, or, at any rate, caused unsoundness in the remaining timber. The Eucalypts are strongly light demanding, and, in consequence, thin out naturally; the regrowth is irregular, and the leading trees easily dominate the smaller stems, which then are liable to die. Forest fires accelerate the process and the forests are, for the most part, thinly stocked. As a result, the forests now remaining cannot, in their present condition, supply permanently all parts of Australia with the necessary timber, especially as the area covered with coniferous light woods is very small, except in Queensland. While a certain quantity of hardwoods is exported, especially from Western Australia, the imports of coniferous timber are very large and steadily increasing. All this has led to the idea of cutting down natural forests and replacing them by artificial plantations of conifers. On the other hand, it is pointed out that, while artificial plantations would involve an enormous expenditure, by proper organisation and sound silviculture the regeneration of the natural forests could be effected by a comparatively small expenditure.

There can be no doubt that Australia will have to take energetic measures to save and improve the remaining timber forests, in so far as this can be done without unduly hindering settlement. In addition, coniferous light timbers should be grown to replace in time those which are now imported. If that policy is adopted, the import of coniferous light woods should gradually disappear, while the export of hardwoods could be very considerably increased.

5. Area of the Forests.

The areas of the forests are given as follows in square miles :—

Area of Forests in Square Miles.

State.	Merchantable.	Unmerchantable.	Total.	Per cent. of Total Area.
Queensland . .	10,000	50,000	60,000	9·0
New South Wales .	17,190	—	17,190	5·5
Victoria . .	4,690	7,810	12,500	14·2
South Australia .	250	5,750	6,000	1·6
Western Australia .	4,770	21,000	25,770	2·6
Tasmania . .	940	16,260	17,200	65·6
The Commonwealth	37,840	100,820	138,660	4·7

The actual area of wooded land is probably greater than that given in this table.

6. Relationship of the State to the Forests.

All the States have Forest Departments, but the staff is described as deficient. At a conference of the Premiers of all the States held lately at Melbourne, at which the Commonwealth Government was also represented, it was decided to establish an Australian School of Forestry of a high standard in New South Wales, the cost and maintenance being borne by contributions from the several States and from the Commonwealth. The Schools now existing will be mentioned in the accounts given of the several States. In the meantime a few Australians have come to Oxford to study forestry, and this move might be continued until Australia has completed the establishment of a high-class school of its own.

The next step should be to consolidate the Forest Laws of the several States. Whether it will be possible to have one uniform law for the Commonwealth, it is impossible to say. Under that law an area sufficient to secure the future requirements of the country should be selected, demarcated and declared permanent State Forests. This is the most urgent question in Australian forestry. The area depends not only on present requirements, but on the probable increase of population, the progress of settlement and the development of industries. It has been estimated that not less than 74,000 square miles of permanent State forests are necessary in the extra-tropical part of Australia. What further areas may be required in the tropical part cannot be stated at present. The question was dealt with at a recent forest conference held at Melbourne, when it was decided to set aside an area of 38,281 square miles (24½ million acres) as permanent National forests. This would be about one-half of the area previously considered necessary. An area of, say, 40,000 square miles should, under efficient systematic management, yield for ever not less than 40 million loads a year, which would satisfy not only Australian requirements, but also allow for an extensive export of hardwood, especially as the unreserved forests would continue to provide a considerable part of the locally required material.

The reserved State forests should as speedily as possible be organised, that is to say, arranged into suitable charges and subdivided into workable units, so that an orderly management can be introduced. Working plans for a number of years should be drawn up, beginning with the forests of greatest importance. These plans, once approved, should not be deviated from except with the previous sanction of Government.

Every effort should be made to preserve and improve all permanent State forests. Their regeneration should, if possible, be effected by natural means, supplemented, if necessary, by artificial help. The idea of replacing the natural forests by new plantations of fast-growing species should be definitely discarded. Such a procedure would be very expensive and risky. Besides, most of the Eucalypts are so fast growing that it would be difficult to find any exotic species worth cultivating which would grow faster than the Eucalypts and at the same time yield good

timber. New plantations should be restricted to the production of light woods in which Australia is deficient, while a brisk export in the highly appreciated heavy Eucalypts should be maintained or extended.

Special attention should be paid to fire protection by the division of the forests into suitable blocks isolated from each other by broad strips of cleared areas, which could be utilized as grazing areas, thus recouping at any rate, part of the cost of fire protection.

While the ordinary forest conservancy belongs to the several States, the question arises whether there is not room for a federal forest administration, not to compete with the State forest administration, but to supplement it at points where forestry assumes a national rather than a local aspect. The Union of South Africa and the Dominion of Canada have such central forest authorities, which have answered very well. In this respect, attention may be drawn to the fact that, in the past, forestry has been too much at the mercy of politics. One Minister has done his best for it, while his successor has acted in the opposite direction. Ministers should not attempt forest management, but leave it to be conducted on a continuous policy by experts. The object should be to get national forestry away from direct political control, and a Federal Forestry Authority might be the means of achieving this. In this respect, a more healthy public opinion has of late been developed, than existed in the past.

The hygienic and æsthetic aspects of forestry should not be overlooked. Australia suffers from the same evil as that existing in Britain, the preponderance of urban over rural population, and the difficult problem has to be solved how to make country life more attractive, so as to reduce the great discrepancy between town and country population. In this respect, forestry can do something; properly organised forests give permanent employment under healthy conditions. The number of men and their families so employed depends on local conditions and on the general progress in the management of the forests. That the number would be very large can be seen when it is remembered that for every systematically managed 100 acres one person will be required all the year round. Life in the rural districts acts as an important means of preserving a stalwart race of men in the country.

The exploitation of timber in Australia is said to be inefficient and costly, chiefly because there are no roads. The Government, it is said, neither constructs them nor does it assist timber workers in making them. If rational forestry is ultimately to be successful the forests must be opened out by means of communication, and especially by roads, which should be so constructed that rails can be laid on them later on if required.

The establishment of amenity forests for the benefit of the people, and especially for the inhabitants of the towns should not be overlooked. The matter will, no doubt, become increasingly important as the population increases. It has even been recommended to plant trees in the broad streets of the big towns, Sydney, Melbourne, Adelaide and others, so as to afford under their shade the comfort and enjoyment of outdoor life, which are obtainable in Southern Europe under a similar climate. With the object of stimulating this class of operations, it is suggested that Government nurseries should provide the necessary trees for distribution at cost price. Arboriculture is a friend of the people, and in South Africa it has done more than anything else to assist national forestry.

7. Income and Expenditure.

Although the royalties on timber have been very low, the revenue derived from the forests has met all expenses connected with them and yielded a substantial surplus. According to the returns contained in the Official Year Book for 1918, the average annual receipts and expenses during the last five years were as follows :—

Year.	Revenue. £	Expenditure. £	Surplus. £
1913—1914 . .	279,815	145,276	134,539
1914—1915 . .	297,254	157,569	139,685
1915—1916 . .	253,309	157,534	95,775
1916—1917 . .	211,930	169,889	42,041
1917—1918 . .	235,582	193,123	42,459
Average . .	255,578	164,678	90,900
Average of previous five years . .	252,233	132,749	119,484

The receipts, as well as the surplus, were rising up to the year 1914—1915; after that the effects of the war made themselves felt. The average rate of royalty on timber prevailing throughout the Commonwealth is about three farthings per cubic foot, as compared with fourpence in South Africa, and it should be substantially raised. At any rate, it seems clear that the forests can provide the funds for an improved system of management, their gradual amelioration and yield capacity, as well as for the establishment of a sufficient area of soft woods.

8. Exports and Imports of Timber.

Before the great war Australia used to export hardwoods and import soft woods; there was generally an excess in the value of the imports over that of the exports. During the war the data have been so much shifted that they have, for the moment, become useless. Under careful management the exports of the excellent Eucalypt timbers should be capable of considerable extension, so that they should exceed the imports.

As far as can be ascertained from the official returns, the imports and exports in 1913 were as follows:—

	Cubic Feet.	Value in £ Sterling.
Imports of Timber	46,000,000	2,926,000
Export of Timber	14,000,000	1,011,000
Excess of Imports	32,000,000	1,915,000

Tanning Bark.	Cwt.	Value in £ Sterling.
Exports	144,000	66,400
Imports	77,700	28,000
Excess of Exports	66,300	38,400

In the following pages detailed information is given for the several States. The data are based on those given in the Reports presented to the Imperial Forest Conference in July, 1920. It will be useful to begin with Queensland, that is to say, at the northern point of the Dividing Range. No report was received from Tasmania.

SECTION II.—FORESTRY IN THE AUSTRALIAN STATES.

I. QUEENSLAND.

[Latitude 11th—29th degrees.]

1. General Notes.

Approximately one-half of the area of the State is situated on each side of the Dividing Range. The eastern part consists chiefly of stratified rocks of different ages from oldest palæozoic to recent origin; granites are found over large areas. The western interior consists almost entirely of lower cretaceous rocks overlaid in places by desert sandstone of upper cretaceous age.

Soils.—Red soils, derived from basalt and allied rocks, are found on the high plateaus in the coastal belts. Black soils occupy areas subject to flooding, and sandy soils prevail in the south-eastern part of the State. The interior country has mostly sedimentary soils over sandstone, red and grey on the higher part and black where subject to periodic flooding.

Rainfall.—Thirty to 145 inches in the coast belt, 5 to 30 in the western half; generally heavier in the north than in the south part of the State. The mean temperature on the coast ranges from 52 to 78 in winter and from 73 to 86 in summer.

2. Main Types of Forest Growth.

Queensland has more or less open hardwoods and the most important softwoods of the Commonwealth.

The Araucaria Type is abundant in the south-west part of the State. Principal species are "Hoop" pine (*A. Cunninghamii*) and "Bunya" pine (*A. Bidwilli*). The natural stand is 10 to 20 trees per acre in mixture with other species. Mature trees give up to 500 cubic feet of sawn lumber. These pines are the chief building timber of the State, and are also used for butter boxes, plywood, &c. Associated with the pines are three species of Flindersia, all valuable hardwoods, also White beech (*Gmelina Leichardtii*) a fine soft wood for carving, Bally gum (*Litsea reticulata*), and pink poplar (*Euroschinus falcata*).

The Jungle Type.—Where the contents of moisture increase, the Araucarias are displaced by more robust moisture-loving species especially of *Meliaceæ* and *Laurineæ*, which grow into trees of large dimensions. In the south-west corner this type consists of southern maple (*Cryptocarya glaucescens*), silky oak

(*Grevillea robusta*), sassafras (*Doryphora sassafras*), rose mahogany (*Synoum glandulosum*), white wood (*Schizomeria ovata*) and others. In North Queensland, under a heavy rainfall and on volcanic soil, a similar profusion of soft woods occurs, of which the chief species was the red cedar, now almost cut out, its successor in public favour being maple (*Flindersia Chatawaiana*), a fine well-grown tree. Other species are silkwood (*Fl. Mazlini*), kauri (*Agathis Palmerstoni*), satinwood (*Dysoxylon Pettigrewianum*), black walnut (*Cryptocarya Palmerstoni*), pencil cedar (*Lucuma galactoxylon*), and others.

The Hardwood Forests consist preponderatingly of Eucalypts. On the moist sands of Fraser Island and the alluvial bottoms of the south-east are found *Euc. microcorys*, *pilularis*, *saligna* and *tereticornis*. These are all useful building woods, 50 to 60 lbs. in weight per cubic foot. On the drier ridges of the coast and in the near west are found ironbark (*Euc. paniculata*, *crebra*, *siderophloia*) and *maculata*, all valuable, very heavy woods, weighing 60 to 80 lbs. per cubic foot. Other associates are *E. punctata*, *propinqua* and *corymbosa*. In the drier west, Acacias replace the Eucalypts.

The Cypress Pine Forests.—The cypress pine (*Callitris glauca*) furnishes the domestic timber of Western Queensland and New South Wales. It occurs either pure or under open ironbark, chiefly in the sandy belts with 20 to 30 inches of rainfall. Drought and fires have thinned them, and prickly pear has appeared in them. The timber is a coniferous hardwood, aromatic, but somewhat knotty and brittle. It is one of the few species which can be grown under drought conditions, and therefore of special value to foresters.

3. Area and Ownership of Forests.

The following data have been given by the local authorities :—

	Square Miles.	Per cent. of Total Area.
State Forests :		
For timber production	6,000	10
Other forests	45,000	75
Total	51,000	85
Corporation and Private Forests	9,000	15
Grand total	60,000	100

4. Relation of the State to the Forests.

Legislation.—There are :—

(1) The State Forests and National Parks Act, 1906.

(2) The Land Act, 1910.

(3) Regulations issued under these Acts.

Provision is made under the first of these enactments for the establishment of State Forests and National Parks, which may not be interfered with except by the authority of an Act of Parliament, but under the Land Act special leases and occupation leases may be granted, nor are the Mining Acts affected by the Forests and Parks Act. The Regulations provide for the control of the forests and parks by the Director of Forests, the preparation of working plans, the methods of disposing of timber and other forest produce, prevention of illegal acts, the authority of forest officers, &c. The Land Act of 1910 deals with Crown lands generally, the removal of timber and certain leases. A further enactment is contemplated to strengthen the control of the forests by the forest service, more especially in dealing with forest fires.

Forest nurseries have been established and experimental planting undertaken, especially of hoop and bunya pines. Natural regeneration is also proceeded with experimentally. Good progress is being made with the construction of forest roads and other means of transport. Water is being supplied to some of the drier reserves by artesian bores, tanks, dams, &c.

The Forest Authority.—The forest service is a branch of the Department of Public Lands. The Director of forests is responsible to the Minister for the management of permanent reservations. The Lands Department controls the leasing of the timber reserves and the reservation of Crown lands for forests.

The forest *personnel* consists of the Director of Forests, to whom the District Foresters are subordinate, who, in their turn, control the Deputy foresters for silviculture, sales, engineering, also the rangers and forest guards.

Education.—A forest school and institute of silvicultural research are under construction at Imbil, Queensland. A generous circulation of items of information on forestry matters has also been adopted. It has lately been decided to establish a

high-class School of Forestry for the Commonwealth in New South Wales, to which Queensland will contribute.

Research has hitherto been conducted in the forest office at Brisbane in wood technology and classification.

The Revenue and Expenditure during the years 1914 to 1918 were, on an average per year, as follows :—

	£
Revenue	68,521
Expenditure . . .	12,070
Surplus . . .	£56,451

5. Increment and Utilization.

The local authority has estimated the annual increment at :—

	Cubic Feet.
Gross increment at 5 cubic feet per acre .	35,200,000
Loss by fire, waste, decay, &c. . . .	26,400,000
Nett annual Increment . . .	8,800,000

The annual utilization is given as follows, timber only :—

	Cubic Feet.	Value, £.
From forests under State control	5,250,000	83,550
From other forests . . .	13,450,000	229,000
Total utilization . .	18,700,000	312,550

6. Forest Industries.

In 1918 the saw milling industry absorbed :—

	Cubic Feet.	Value, £.	Number of Men Employed.
Pine timber .	9,000,000	—	—
Cedar . .	30,000	—	—
Hardwoods .	5,970,000	—	—
Total .	15,000,000	1,340,000	3,500

Considerable employment is also afforded in log getting, railway, mining, and pole-timber getting. Probably some 2,000 persons are engaged in these activities. Fuel and fencing operations

provide employment for a large number of persons, while about 100 are engaged in the getting of sandalwood, guano, and mangrove bark.

7. Exports and Imports.

	Cubic Feet.	Value, £.
Imports . . .	6,000 ..	1,500
Exports . . .	2,000,000 ..	500,000
Excess Exports .	1,994,000 ..	498,500

8. Summary and Outlook.

	Cubic Feet.
Utilization	18,700,000
Less Exports	2,000,000
	16,700,000
Add Imports	6,000
Total Home Consumption . .	16,706,000
Deduct Net Increment . .	8,800,000
Excess Consumption over Increment .	7,906,000

The reasons for the apparent overcutting are the excessive realisation of timber values by private proprietors and the enormous loss by waste. These drawbacks must be met by :—

(1) The formation of an area of permanent State forests, sufficient to meet future requirements.

(2) The building up of an efficient forest staff capable of managing the State forests systematically for a sustained yield, and the reduction of the present waste to a minimum, especially by organising an efficient system of fire protection.

(3) Placing the Forest Branch under one Minister instead of under two, and keeping it free from political controversy.

II. NEW SOUTH WALES.

1. Short General Description.

New South Wales is situated between the 28th and 38th degree of southern latitude and between the 140th and 154th degree of

eastern longitude. The greater part of the area is situated to the west of the Dividing Range, which attains its greatest height in the south of the State at Mount Kosciusko with 7,305 feet. The State can be divided into the following three main sections :—

(1) *The Coastal Range* has a width of about 60 miles in the centre, but is much narrower at the north and south ends. It contains two coal measures, the most important of which is situated to the north, west and south of Sydney, occupying an area of about 25,000 square miles and being one of the most valuable assets of the State. The coastal region is largely composed of post-tertiary deposits with very rich agricultural areas and the most important forests of the State.

(2) *The Tablelands of the Main Divide.*—The New England massif in the north is composed of sediments of carboniferous age with large masses of granite. The Blue Mountain massif in the centre presents a monotonous level plain, consisting of great masses of sandstone with a band of readily weathering shale ; below the sandstone are soft shales and coal. The Kosciusko massif in the south consists chiefly of granite. Two important rivers flow from its western slopes, the Murray and the Murrumbidgee.

(3) *The Western Plains* extend from the western foothills to the great tableland ; they consist of granite rocks and sediments of various ages, and they are covered by post-tertiary deposits, flood loams, &c. ; but in some cases the older formations still rise above them.

The Climate ranges from subtropical to temperate in the coastal zone, from temperate to subalpine in the highland zone, from temperate to arid in the interior and to extreme aridity in the west. The rainfall ranges from 80 inches in the subtropical zone to 9 inches (and even less) in the extreme west.

2. Main Types of Forest Growth.

(1) *The Hardwood forests* may be divided into two sub-types :—

(*a*) The luxuriant growth in the moist parts of the coastal zone and in a few favoured places in the highland zone.

(*b*) The drier forests in the interior zone west of the highland zone and on the drier parts of the coastal zone.

Generally, it may be said that on suitable soil the development of the hardwoods depends on the quantity of water at their disposal.

The coastal hardwood forests consist of an over-wood of numerous species of Eucalypts and an underwood of miscellaneous shrubs and small trees, of which species of Casuarina and Acacia are most abundant. The principal species in the coastal zone are *E. pilularis*, *microcorys*, *resinifera*, *paniculata*, *propinqua*, *saligna*, *tereticornis*, *corymbosa*, *Tristania conferta*, *Syncarpia laurifolia*. On small belts appear pure woods of *E. pilularis* and *maculata*. In the southern half of the coastal zone appear species which require a more temperate climate, such as *E. longifolia*, *botryoides*, *siberiana*, *capitellata*, *Muelleriana* and *goniocalyx*. Formerly the coastal belt of hardwoods was almost continuous, now it has been much interrupted.

The development of the Eucalypts on the highland and interior zones is generally inferior, especially in the western half of the latter zone. In the interior zone the Eucalypts are frequently interspersed with Callitris, forming forests of great value. Of special importance is the *E. rostrata* type on the flats along the Murray river which are occasionally flooded.

The yield per acre from hardwood forests is generally low, even in the best localities, owing to the tendency in over mature trees to faults, to the ravages of fire and white ants, and to the exacting demands of the trade. It is rare to obtain an average yield of 1,000 cubic feet of marketable timber per acre from virgin forest of over a 1,000 acres in extent, while 2,000 cubic feet would be quite an exceptional yield.

(2) *The Cypress Forests* are composed chiefly of *Callitris robusta* and *calcarata*, the former being by far the more valuable and abundant. It occupied formerly considerable areas of the plains in the interior zone, but fire and settlement have reduced it to isolated patches. It flourishes best in well drained, deep, loamy sand, and it is found either pure or mixed with Eucalypts where the rainfall amounts to 15 to 20 inches. It is very sensitive to fire and does not cover the soil well. Regeneration has been

prevented by rabbits and sheep. The present yield is insignificant.

(3) *The Brush Forest* is restricted to the warm climate of the coast, where it finds an abundant rainfall and fertile soil. It contains a miscellaneous collection of species, of which some are valuable, such as *Cedrela australis*, *Gmelina Leichardtii*, *Araucaria Cunninghamii*, *Flindersia australis* and *Grevillea robusta*. Some of the existing species are used in the place of imported softwoods. The brush forest provides a good canopy and enriches the soil by humus.

3. Area of Forests.

Only the area of merchantable forests has been estimated; neither that of the other forests nor that of the agricultural land is given. The data are therefore reduced to the following :—

	Square Miles.	Per cent. of Total Area.
Merchantable forests	17,187	5·55
Other land	292,268	94·45
Total	309,455	100·00

4. Ownership of Forests.

	Square Miles.	Per cent. of Total Area of Forest.
State timber forests	7,881	45·9
Other State forests	4,619	26·9
Total State forests	12,500	72·8
Private forests	4,687	27·2
Total	17,187	100·0

5. Relation of the State to the Forests.

Legislation.—The Forestry Act, No. 55 of 1916, is the latest enactment on the subject. It provides for :—

(1) The dedication, reservation, control and use of State forests, timber reserves, and Crown lands for forestry.

(2) The appointment of a Commission to administer the Act,

with power to sell and convert timber and other produce, and generally manage the forests.

Assessment surveys are now being made, a proper organisation introduced, the silvicultural treatment determined, roads constructed, the water supply attended to, fire protection organised, &c. Some 60,000 acres of land have been selected for the planting of conifers (exotics), and the work has been commenced.

The Forest Authority consists of a Commission of 3 members, constituted under the Forest Act. The country has been divided into 12 Districts, each with a resident District Forest Officer assisted by a staff of assistants, foresters and guards. District Inspectors go round and enquire into the progress of the work. There are also Forest Surveyors and Assessors, who organise and prepare working plans, as well as nursery men and planters. The whole staff comprises 254 members, of whom 32 are at headquarters in Sydney and 222 in the field. The powers and duties of the Commission are defined in the forest law, and they are divided into three parts: (1) Administration and Finance; (2) Forest Management; and (3) Commercial Development.

One half of the gross amount received by the Commission from royalties, licences and permits, and from the sale of timber (except that used for the construction of sawmills, &c.) is carried to a special account and used for afforestation, survey, improvement of the State forests and timber reserves, means of transport, &c.

Education.—In the past, forest officers have been chosen from applicants with due regard to natural fitness. A new forest school is now located in a State forest near Gosford, and it has been decided to establish a high-class School of Forestry in New South Wales for the Commonwealth generally. The Commission issues bulletins, leaflets, &c., and also publishes a Journal to educate the people as to the importance of proper forest conservancy, especially as regards fire protection.

Research.—Systematic research upon the commercial possibilities of forest produce has been started in respect of pulping, resin, fibres, properties of timber, essential oil value of foliage, dry distillation of wood, value of wood ashes and wood tar. In the forest, investigations are conducted into the rate of growth, afforestation, methods of thinning, coppicing, &c.

6. Income and Expenditure.

Averages of the years 1917 to 1919 :—

	£
Annual Income	84,281
Annual Expenditure	99,425
Average Annual Deficit	£15,144

7. Increment and Utilization.

There are not sufficient data available by which the annual increment could be estimated.

The annual utilization, partly based on statistical data and partly estimated, is as follows :—

	Cubic Feet.	Value £.
From forests under State control	20,223,920	2,000,000
From other forests	4,044,780	400,000
Total utilization	24,268,700	2,400,000

8. Exports and Imports.

	Cubic Feet.	Value £.
Average annual Imports	12,241,500	1,046,400
Average annual Exports	1,633,700	201,100
Excess of Imports	10,607,800	845,300

9. Summary and Outlook.

	Cubic Feet.
Utilization	24,268,700
Less Exports	1,633,700
	22,635,000
Plus Imports	12,241,500
Total Home Consumption	34,876,500

Consumption per head of population, 17·4 cubic feet.

At the present rate of cutting it is considered that the Hoop pine resources will be exhausted in 12 years ; those of Cypress

timber can be maintained for some time by opening out communications to untouched forests. The past rate of cutting in hardwoods can be maintained indefinitely under a proper system of management.

It would appear that forest conservancy in New South Wales has made a good start on rational lines. Special attention should be paid to :—

(1) The formation of permanent State forests of sufficient extent to meet future requirements.
(2) The preparation of working plans based on the principle of a sustained yield.
(3) Afforestation with conifers to provide softwoods instead of importing them.
(4) Organisation of efficient fire protection, grazing control and, if possible, extermination of rabbits.
(5) Economic lumbering.
(6) Opening out of communications by roads and other means of transport.
(7) The prevention of political interference with the action of the Forest Commission.

III. VICTORIA.

1. Configuration and Climate.

Victoria is situated between the 35th and 39th degree of southern latitude and between the 141st and 150th degree of eastern longitude. Its area is 87,884 square miles and its population 1,315,551 (in 1911).

The Dividing Range traverses the State from east to west, generally at a distance of 60 to 80 miles from the coast. It rises to various heights, ranging between 1,500 and 4,000 feet, but to 6,000 feet in the north-eastern part of the State. About one-third of the country consists of rugged highlands and two-thirds of plains below 1,000 feet elevation. The highlands consist almost entirely of carboniferous, Devonian, Silurian and Ordovician (gold bearing) sedimentary rocks.

The Soils along the river flats have mostly been taken up for cultivation, the forests being relegated, more and more, to the poorer areas. The major portion of the State consists of sandy, clayey, or gravelly loams.

Climate.—The climate of Victoria is well suited for Europeans. The maximum temperature experienced at Melbourne during 63 years is 111 degrees, the minimum 27, and the average annual temperature 57 degrees. The rainfall is not heavy, the average being given as 24 inches. It varies, however, considerably, the heaviest fall occurring on the south side of the Dividing Range, while the driest parts are situated to the north of it. The following data give the areas subject to different degrees of rainfall :—

Rainfall.	Area in Square Miles.
Under 15 inches. . .	19,912
15—20 „ . . .	12,626
20—30 „ . . .	29,317
30—40 „ . . .	14,029
40—50 „ . . .	7,055
50—60 „ . . .	3,348
Over 60 „ . . .	1,597

2. Types of Forest Growth.

There are four main types :—

(1) *The Coastal Region*, extending some 50 miles northward, has forest consisting of *E. capitellata*, *eugenioides*, *Muelleriana*, and *obliqua*. Near the shore they are interspersed with *Casuarina*, *Banksia* and *Myopsorum*. Further northward, where elevation increases, at about 100 miles from the coast, the river red gum (*E. rostrata*) is found in quantity on the sandy clays along streams. Where elevation rises to about 2,000 feet the following species appear : *E. Globulus*, *regnans*, *goniocalyx* and *obliqua*, with valuable underwoods, such as blackwood, beech and satin-box. Various other Eucalypts are found in this region, in some parts *E. Sieberiana* occupying as much as 50 to 75 per cent. of the forest growth.

(2) *In the Mountain Region* are found *E. capitellata*, *obliqua*, *viminalis*, *Globulus*, *macrorrhyncha* and *meliodora*. In the east on higher levels are found *E. delegetensis* with *regnans*, *obliqua*, *and amygdalina* with *Globulus* at intervals towards the source of the Murray River. The mountain forests, excepting strips damaged by fire, are densely stocked, and, if opened by roads

or tramways, would give heavy yields per acre of excellent hardwood. From 4,500 feet upwards to 6,000 stunted Eucalypts grow.

(3) *The Foothills*, stretching from the Dividing Range northward, and gradually falling to the plains, bear three valuable species, *E. sideroxylon*, *leucoxylon* and *hemifloia*, which furnish the best and most durable timber for engineering works; they obtain their best growth on shales and slates in narrow valleys lying between hill ranges of ironstone, sandstone and quartzite in the auriferous belt of country.

(4) The River Basins of the Murray and other streams flowing through the northern plain, bear broad belts of river red gum (*E. rostrata*) which is perhaps the most useful hardwood in the State. It grows best on land which is subject to annual inundation. The total area of forest of this class is estimated at 625 square miles.

3. Area of Forests and Other Lands.

		Square Miles.	Per cent. of Total Area.
Agricultural Land		43,750	49·9
Forest, Merchantable	4,687		5·3
Forest, Unprofitable	7,813		8·8
Forest, total		12,500	14·1
Other land		31,634	36·0
Total Area		87,884	100·0

4. Ownership of the Forests.

	Square Miles.	Per cent. of Total Forest Area.
The State timber forests	6,500	52
Other State forests	5,500	44
Total	12,000	96
Corporation forests	188	1·5
Private Proprietors' forests	312	2·5
Total	12,500	100·0

5. Important Forest Produce.

Victoria has practically no coniferous forests, but is rich in hardwoods. Amongst the latter the Eucalypts take first place. There are about 20 important species, which have been mentioned above. There are also fine grained woods amongst which may be mentioned *Acacia Melanoxylon* and *Fagus Cunninghamii*.

Eucalyptus oil is produced in considerable quantities. The species principally used for the purpose are *E. polybractea*, *sideroxylon*, *leucoxylon*, *Globulus*, and *amygdalina*. The output from the State forests exceeded 360 tons in 1918—1919.

Tanning bark is obtained from 5 species of Acacia (Wattles). There was a considerable export of the bark, but it has fallen off considerably of late, owing to damage by fire, dear labour, and large imports from Natal.

6. Relationship of the State to the Forests.

Legislation.—A Forest Act was passed in 1907 and amended in 1915. It provided a separate department under a Minister and a Conservator of Forests. The latter had, however, little power. It also provided for the permanent and temporary dedication of reserves. In 1918 a new Act was passed which provided for :—

(1) The removal of forests from political control.

(2) The creation of a Commission of Management consisting of 3 members with wide powers as regards the fixing of rates for forest produce, the acquisition of land by purchase or exchange, the conduct of forest industries, and the management of the forests generally.

(3) The preparation and control of working plans for the proper regulation of the yield.

(4) The appointment and discharge of members of the forest staff.

(5) An annual appropriation equal to one-half of the annual forest revenue with a minimum of £40,000.

(6) The examination and survey of undemarcated mountain forests, and recommendation of their permanent reservation to the Governor-in-Council.

Methods of Forest Development.—(*a*) About 800 square miles of forests have been brought under efficient fire protection.

(*b*) Areas near gold fields have been planted, 5 square miles with hardwoods and 11 square miles with softwoods. The hardwoods are Eucalypts, and the softwoods are Montery pine (*P. insignis*), Corsican and Pinaster pines, Douglas fir, western yellow pine, Canary pine and Japanese red pine (*P. densiflora*).

(*c*) Regeneration of Natural Forests. The Victorian Eucalypts produce large quantities of seed, which, it is stated, may remain dormant for 6 to 10 years before germination is induced by the removal of the forest cover in timber cutting operations, or by the action of light fire passing over the area. As the Eucalypts are light-demanding, they regenerate freely where the merchantable timber has been cut, provided fire is kept out after regeneration and damage by rabbits prevented.

(*d*) From 3 to 4 million young plants, chiefly conifers, are raised annually ; some of these go to the State plantations, while others are given free of charge, or at a low rate, to settlers, together with the necessary advice.

The Forest Authority.—The three Forest Commissioners are appointed for 5 years. There are at present 5 Chief Foresters, 21 Foresters and 14 Assistant Foresters, with a staff of foremen, labourers, &c. There is also a Chief Superintendent of plantations and nurseries. The Commission has control of all State forests and of forest produce on other Crown lands. Their duty is to carry out the provisions of the Forest Acts as indicated above.

Education, Research and Experimental Work.—A forest school was established in 1910 at Creswick, on the Dividing Range. Pupils enter at the age of 14 to 17 years and go through a 3 years' course of instruction. There are classes in the morning and practical work in the afternoon in the adjoining nurseries and plantations ; there are also 14,000 acres of State forests close by. Victoria is taking part in the movement for establishing a high-class School of Forestry for the use of the Commonwealth generally.

No research or experimental work has, so far, been carried on beyond investigations on various timbers and the planting of exotic trees.

7. Increment and Utilization.

The increment differs very much, and data for an accurate estimate are not available. It is stated that approximately the

average annual increment of the State forests may be placed at 30 cubic feet and the loss by fire, waste, &c. at 7 cubic feet, giving a net increment of 23 cubic feet per acre and year. On that assumption the following figures are given :—

Area of forests less mallee scrub	9,375 square miles.
Total Increment	180,000,000 cubic feet.
Loss	30,600,000 ,,
Net Increment	149,400,000 ,,

The annual utilization is given as follows :—

	Timber, Cubic Feet.	Fuel, Cubic Feet.	Value £.
Under State control	7,500,000	20,140,000	775,700
Under other control	833,300	20,000,000	275,000
Total	8,333,300	40,140,000	1,050,700

Also :—

	Tons.	Value £.	
Wattle bark, the State	500	3,500	
Tanning bark, others.	4,000	24,000	
Charcoal, the State	230	11,625 (?)	
Eucalyptus oil, State.	360	53,700	
Total value		92,825	92,825
Grand total of all produce			1,143,525

8. Forest Industries.

The use of indigenous timbers has steadily increased of late. The following data show the extent of forest industries :—

Produce consumed	51,950,000 cubic feet.
Value of produce	£1,869,485
Number of persons employed	5,126.

9. Exports and Imports of Timber.

Annual average of the years 1913 to 1918 :—

Imports.	10,365,770 cubic feet.
Exports.	74,900 ,,
Excess of Imports over Exports	10,290,870 ,,

The exports consist chiefly of manufactured hardwoods to neighbouring States. The imports consist of softwoods from the Baltic, United States, Canada and New Zealand.

10. Summary and Outlook.

Timber and Firewood :

	Cubic Feet.
Utilization	48,473,300
Less Exports	74,900
	48,398,400
Plus Imports	10,365,770
Total Consumption	58,764,170
Net Increment	149,400,000
Excess of Increment over Consumption .	90,635,830

The consumption per head of population amounts to 41 cubic feet. The supply of forest produce is not likely to fall short of the demand, even if the population should increase as it is expected to do, provided systematic forestry is steadily adhered to in the future. The main points to be attended to in the immediate future are :—

(1) The speedy establishment of permanent State forests of sufficient area to meet future requirements.

(2) Efficient protection and management of the permanent State forests, including the drawing up and carrying out of working plans based on the principle of a sustained yield.

(3) The planting of an appropriate area with softwoods (Conifers).

(4) The development of the export of hardwoods, so as to pay for the establishment of the softwood plantations.

IV. SOUTH AUSTRALIA.

1. General Notes.

South Australia has no high mountains, an uncertain and deficient rainfall, and a high temperature during summer ; hence, it has very little forest. There is the Mount Lofty Range near

the gulf of St. Vincent, 1,000 to 2,000 feet in elevation, with a rainfall of 20 to 35 inches and some fine merchantable timber, but the bulk of the land has passed into private hands ; principal species are *E. obliqua*, *rostrata*, *leucoxylon* and *fasciculosa*. The soil is mainly light, overlying clay.

Another area of fair forest country is found in the Flinders Range situated to the east of the Gulf of Spencer with a rainfall of 21 to 30 inches. The soil here is sandy, or a good clay-loam at an elevation of 1,000 to 3,000 feet. The chief species are *E. hemiphloia*, *leucoxylon*, *rostrata* and *corynocalyx*. There are some other ranges here and there rising to 500 and perhaps 1,000 feet, which generally produce *Casuarina quadrivalvis*, *E. odorata* and *leucoxylon*. Between these ranges wide plains occur frequently overlying limestone, with an uncertain rainfall of perhaps 12 inches, and with a growth of dwarf Eucalypts or " mallee " attaining a height of 10 to 20 feet.

In the south-east of the State appear wide stretches of sandy country overlying dolomite limestone at a slight elevation, on which *E. capitellata* is found, and in damper parts, *E. rostrata*.

2. Types of Forest.

The dominating type of forest growth in South Australia is that of the Eucalyptus genus, the principal species of which have been indicated above. They appear only as real timber trees where the rainfall is ample for timber production. Where the rainfall is small and the climate fairly arid, the extent of such country being very great, only " mallee " scrub is found, consisting of dwarf Eucalypts.

Casuarina quadrivalvis, *Lehmannii*, *lepidophloia* and *glauca* usually appear as an under-forest amongst the larger timbers, as well as in pure masses in the more arid parts of the State. Various wattles, such as *Acacia pycnantha*, *decurrens*, *retinodes* and *Melanoxylon* usually grow under the bigger forest trees, but some species, as the " Mulga " (*A. aneura*), *A. sentis* and *cambagei*, form pure stretches in the dry interior.

Callitris robusta and *propinqua* are sometimes found mixed with larger trees as underwood, but also in pure patches in the drier parts of the State.

3. Area of Forests.

The area of the natural forests amounts to 225 square miles, of which 77 are fairly timbered, the rest being more or less scrub. Owing to the small area, the State has planted, with great success, 25 square miles with conifers, making up to date the total forest area 250 square miles, all belonging to the State.

4. Relationship of the State to the Forests.

Legislation.—The Forest Act of 1882 provides that the control of the forests shall vest in the Commissioner of Forests with ample powers to deal with all circumstances which may arise.

Administrative Methods of the Department of Forestry.—An efficient system of fire protection has been in progress for many years. The planting of waste and poorly-timbered areas was commenced over 40 years ago and 25 square miles have been successfully stocked, partly with hardwoods and partly with pines. Some of the latter, 37 years old, have lately been cut and yielded an average annual increment of 222 cubic feet per acre, including all material down to 3 inches.

Assistance given to Forestry.—The Department has given during 38 years 10,140,000 plants to private applicants and corporations, as well as expert advice when asked.

The Forest Authority.—The Forest Department is administered by the Conservator of Forests, subject to the control of the Commissioner of Forests, who is a member of the Government; the former is assisted by a forest inspector and foresters and assistant foresters, foremen and nurserymen.

Education, Research and Experimental Work.—The subordinate staff obtain their training in the forests. The higher officers are now trained at a forestry course established at Adelaide University, but the State is taking part in the project of establishing a high-class School of Forestry in New South Wales.

The Lecturer in Forestry has carried out some useful work of an experimental character on the artificial seasoning of timber.

No data are available from which the Increment, Utilization, Forest Industries, Exports and Imports, or a summary could be given. It can be stated only that the consumption far exceeds the

production, that hardwoods are imported from the adjoining States, but that the coniferous plantations already established, and to be established, will ultimately overtake the demand for softwoods.

V. WESTERN AUSTRALIA.

1. Configuration and Climate.

The area of Western Australia amounts to 973,920 square miles. Of this large area only the south-western corner is of real importance from a forest point of view. All the rest of the area consists apparently of savannah, mallee, and mulga tracts.

The true forest range is about 200 miles long from the south-western corner northward, and it lies at an elevation of about 800 feet above the sea. It is separated from the sea on the west by a low-lying plain of sand and coastal limestone hills. On the east the country rises to the central plateau. The forest belt is well watered.

The prime forest region consists largely of granite and gneiss; in the jarrah region the granite is capped with laterite. In the savannah forest all geological formations occur, and it is a question of rainfall whether the ground is stocked with savannah, mallee or mulga jungle. In the karri region the soil is of better quality, especially where karri and marri (*E. calophylla*) grow together. In the savannah forest the soil is generally of an excellent, heavy description and it is fast being occupied by the farmer as far inland as the rainfall is sufficient for the growth of wheat.

Climate.—It is maintained by some people that the true forest area of Western Australia is the most healthy part of Australia. The following data were recorded in 1918 :—

	Shade Temperature, Degrees.			Rainfall, Inches.
	Mean.	Maximum.	Minimum.	
Perth	65	107	38	40
Bridgetown	59	104	27	39
Busselton	62	105	35	38
Karridale	61	95	29	49
Albany	62	93	37	41

In this region the rain falls during winter, April to September. The summers, October to March, are hot and dry. On going east or north the rainfall rapidly diminishes and the extremes of

heat and cold increase. In the tropical north the seasons are reversed; rain falls during October to April, between 20 to 29 inches; the mean temperature ranges between 75 and 85 degrees. Between the tropical north and the south lies a belt of country where very little rain falls.

2. Main Types of Forest Growth.

These are :—

(1) The Jarrah Forests (*E. marginata*).
(2) The Karri Forests (*E. diversicolor*).
(3) The Wandoo Forests (*E. redunca var. elata*).
(4) The Tuart Forests (*E. gomphocephala*).

The *Jarrah Forest* extends over an area of some 12,600 square miles and reaches its best development on the laterite-capped Darling Range, where it reaches a height of 100 feet, and frequently forms 95 per cent. of the growing stock. Its principal associates are *E. calophylla*, *patens*, and *megacarpa*. It is only on secondary laterite and alluvial soil that the associates become predominant. The prime jarrah forests contain an undergrowth of smaller trees, of which *Casuarina Fraseriana* is the tallest (up to 45 feet). A still lower story is formed by a wealth of shrubs, but no grass. The crowns of jarrah do not interlock; hence, they give a very light cover. There is almost a complete absence of humus, due to periodic fires which not only seriously interfere with the natural regeneration, but also do damage to poles and even full grown trees. The results are defects in the timber, such as rotten hearts, hollow logs, gum pockets, double crowns and twisted grain.

The growing stock varies very much, but no data are available to estimate the rate of growth or the growing stock per acre. In 1918—1919 the output of jarrah amounted to 128,747 loads. The selection of the trees to be cut is left to the saw-miller, provided that no trees under 90 inches girth are cut. At present the utilization is many times the increment, and the cut-over areas are left in a deplorable condition. Besides saw-millers, there were 157 hewers at work in 1918—1919, who prepared railway sleepers.

Karri is restricted to the wettest part of the State, that is to

say, localities with a minimum rainfall of 35 inches, situated in the south. The tree reaches a height of 200 feet (one 278 feet high having been measured). The karri forests are not pure; they are intersected by belts of jarrah and by belts of mixed karri and marri (*E. calophylla*), pure marri, or marri and blackbutt (*E. patens*). The soil in the karri localities is deeper and richer than that in the jarrah forests; in consequence it is being occupied for agriculture. As a lower story, *Casuarina decussita* and *Banksia grandis* are found here and there. Karri gives a denser cover than jarrah; there is a dense undergrowth of small trees, chiefly *Leguminosæ*, and a good layer of humus. Fires occur, but not quite as frequently as in jarrah forests. Still, they do a great deal of damage. No supervision is exercised over the cutting of karri, except that no trees under 108 inches girth are allowed to be cut. The state of the forest, after the saw-miller has done with it, is, if possible, almost worse than in the case of the jarrah forests.

Wandoo Forest is confined to a very small area on the north-eastern end of the prime jarrah belt, but larger areas of it are found in the savannah forest. They can do with a few inches less rain than the jarrah forests. The soil of the tract is laterite, but there is also some clay soil. Wandoo forests afford little cover.

Tuart Forest is found on the limestone fringe near the coast. The soil consists of sand over limestone. The tree reaches a height of 120 feet, and it forms pure stands with an under story of peppermint (*Agonis flexuosa*) and *Banksia grandis*. The cuttings have been very wasteful, and owing to grazing and fires there has been no regeneration during the last 50 years.

In addition to the trees mentioned above, a great many others appear. There are numerous other species of Eucalypts, a sandalwood (*Santalum cygnorum*), a pear (*Xylomelum occidentale*), acacias and others. Large quantities of firewood are consumed, especially in the goldfields, also pit-props and other mining timber.

3. Area of the Forests.

The following data show the distribution of the area of the State :—

		Square Miles.	Per cent. of Total.
Agricultural Land		92,826	9·50
Forests, Merchantable :			
Jarrah	4,200		
Karri	400		
Wandoo	160		
Tuart	8		
	4,768		0·48
Forests, Unprofitable, &c. :			
Jarrah	8,400		
Karri	400		
Wandoo	12,000		
Tuart	200		
	21,000		2·12
Total Forests		25,768	2·60
Other Lands		857,326	87·90
Grand Total		975,920	100·00

The 21,000 square miles of unprofitable forests are included in the Surveyor-General's estimate of land reserved for agriculture, and mixed karri and marri lands may also be made available for the same purpose.

4. Ownership of the Forests.

Except in the earlier time of settlement, the right to the soil has been reserved in issuing timber-cutting licences. Forest land has, however, been alienated to settlers. The jarrah area was saved, owing to the inferior quality of the soil. In the karri country the alienation for farming has been more serious. At the present time the State and private proprietors own the following areas in the prime timber area, in square miles :—

	The State.	Private Proprietors.	Total.
Jarrah	4,200	150	4,350
Karri	400	—	400
Wandoo	—	160	160
Tuart	5	3	8
Total	4,605	313	4,918
Percentage of total	93·6	6·4	100

The total is 150 square miles more than the area given above ; there is no explanation for it available.

5. Relationship of the State to the Forests.

Legislation.—In 1918 an Act to provide for the better management and protection of forests was passed. Its main provisions are as follows :—

(1) The control and management of all matters of forest policy are vested in the Department of Forestry, the permanent head of which is the Conservator of Forests, appointed for 7 years and responsible to the Minister of Forests.
(2) Candidates for appointment to the professional division of the Department must possess a degree or diploma of a recognised School of Forestry.
(3) State forests shall be dedicated by the Governor-in-Council ; areas once dedicated can be revoked only by both Houses of Parliament.
(4) Timber reserves may be established by the Governor-in-Council ; they can be revoked, and are then dealt with under the Lands Act.
(5) Working Plans shall be prepared by the Conservator of Forests and approved by Government ; they cannot be altered except on the recommendation of the Conservator.
(6) The Conservator grants permits and licences to obtain forest produce.
(7) Leases of forests may not be granted for more than 20 years.
(8) The Act prescribes penalties for forest offences.
(9) The Act authorises the issue of Regulations for the proper protection of the forests generally and especially for efficient fire protection.
(10) Three-fifths of the net revenue of the Department shall be paid into a special fund to be used solely for forest work.
(11) Private plantations of 10 acres and over shall be exempt from local Government rates and taxes.

Administrative Measures have been taken since the passing of the Act. The preparation of working plans was commenced in 1919 in the jarrah and tuart forests. Road construction was commenced. Plantations of softwoods (*Pinus insignis*) had been commenced some 20 years ago, but the results were not satisfac-

tory. A new start has now been made with Cluster pine (*Pinus maritima*). It is stated that direct sowing has been practised and that it answers well. An area of 25,000 acres has been taken up, 19 miles from Perth, which it is proposed to plant at the rate of a square mile a year. A State nursery has been in existence for 19 years, from which about 100,000 plants were distributed annually until 1917 free of charge to settlers and public bodies. Now cost price is charged for the plants. The advice of forest officers is always at the disposal of planters. Seeds of wattles have also been distributed.

Education.—Western Australia is taking part in the establishment of the Commonwealth School of Forestry in New South Wales, where the superior officers will be trained in future. The subordinate staff has so far been trained on the apprentice system under the control of the superior staff.

Research.—A beginning has been made in investigating the pulping qualities of karri and jarrah timber, also as regards essential oils, the kiln drying of timber, and some botanical matters.

Revenue and Expenditure.—The average annual receipts and expenditure during the years 1909—1914, amounted to :—

	£
Annual Revenue . . .	42,973
Annual Expenses . . .	10,284
Annual Surplus . .	£32,689

The corresponding figures for the year 1918—1919 were practically the same.

6. Increment and Utilization.

There are no data from which anything like an approximate estimate of the increment could be made. In a rough way it has been placed at 13,315,000 cubic feet in the round.

The utilization of merchantable timber is given as follows :—

	Cubic Feet.	Value £.
Jarrah . .	12,567,650 . .	?
Karri . .	714,050 . .	?
Tuart . .	40,950 . .	?
Wandoo . .	39,650 . .	?
Others . .	77,050 . .	?
Total .	13,439,350 . .	930,884

The above data represent squared and sawn timber, and the quantity is equivalent to 40,318,050 cubic feet in the round. In addition about 39,100,000 cubic feet of firewood and mining timber were used, making a grand total of about 80,000,000 cubic feet. It would thus appear that utilization considerably exceeds the increment.

7. Forest Industries.

It is estimated that 8,027 people are occupied in forest work, but that number does not include persons working in minor industries which employ less than 4 persons each.

8. Exports and Imports.

The following data represent the average of the 11 years 1909 to 1919 :—

	Cubic Feet.	Value £.
Exports . .	9,066,450	689,104
Imports . .	911,050	97,803
Excess of Exports .	8,155,400	591,301

9. Summary and Outlook.

Timber only :

	Cubic Feet.
Utilization	13,439,350
Less Exports	9,066,450
	4,372,900
Plus Imports	911,050
Total Home Consumption .	5,283,950

These data represent the timber in a worked-up condition, that is to say, sawn, or at any rate, squared. According to the statement of the local authorities the home consumption must be multiplied by three to represent it as timber in the round, making it 15,851,850 cubic feet. It follows that the home consumption exceeds the annual increment as estimated by the local authorities by about 2,536,850, quite apart from the excess of exports over imports.

There seems to be no doubt that, with the present method of

cutting, the stock of jarrah timber, at any rate, is rapidly being diminished. The local authorities believe that the big saw mills can be supplied for not more than 15 years; that after that smaller mills will go round and pick up the trees which the big mills did not consider sufficiently remunerative to handle, and thus provide the necessary material for a further limited period. On the whole, then, the prime timber forests of Western Australia have been recklessly overcut in a manner involving a terrible loss of material. The necessity of a radical change has, however, been recognised, steps are now being taken to introduce a rational treatment of these once magnificent forests, and above all, to organise an efficient system of fire protection.

It has not been overlooked that, outside the prime timber forests, there are other areas which can be brought under contribution by the opening out of means of transport, and thus give more time for the re-establishment of the prime forests. Investigations have been started to ascertain the amount of the merchantable material available from these sources.

The energies of the Department should in the immediate future be devoted to the following matters :—

(1) The establishment (dedication) of Permanent State Forests of sufficient area to assure a supply of timber and other forest produce in the future, taking into consideration the probable increase of the population.

(2) The preparation of working plans for the State forests arranged on the basis of working for a permanently sustained yield.

(3) Efficient protection of the State forests, more particularly as regards protection against fire.

(4) More economic working of the forests.

(5) Development of research on questions of importance in respect of systematic forestry.

(6) Instruction of the public as regards the importance of efficient forest conservancy.

(7) Above all, the building up of an efficient staff of forest officers to carry out the programme.

There are not sufficiently accurate data available to give a detailed account of Forest operations in Tasmania.

H. FORESTRY IN THE DOMINION OF NEW ZEALAND.

SECTION I.—SHORT ACCOUNT OF NEW ZEALAND.

New Zealand was established a British Colony in 1840, and it became a self-governing Dominion in 1907. It consists of the three islands, forming New Zealand proper, and a series of groups of islands in the Pacific Ocean. On the present occasion, only the former will be dealt with. They are :—

North Island, with an area of	44,130	square miles.
South Island, with an area of	58,120	,,
Stewart Island, with an area of	662	,,
Total	102,912	,,

They are situated between the parallels of 34 and 48 South, and the meridians of 166 and 179 East. The land stretches mainly from north-east to south-west, with a north-westerly bend in the north of North Island.

1. Topography.

Configuration.—The surface of New Zealand is greatly diversified. High mountain ranges stretch from East Cape in the north-east to West Cape in the south-west. In the North Island, the elevation of these mountains seldom rises above 6,000 feet, but there are volcanic peaks situated outside the mountain chains, which reach up to 9,000 feet and have their upper slopes covered with eternal snow. The highest parts of the ranges are in South Island, and the central part, called the Southern Alps, reaches up to 12,349 feet.

The mountains are surrounded, in varying breadth, by Downs. The latter are described as an elevated sea floor, which, owing to erosion, has acquired a hilly surface. The downs seldom rise above 2,000 feet ; they have generally a good fertile soil. Where level enough, they are admirably suited for agriculture ; where more hilly, they form excellent pastoral ground. The lower beds are associated with coal, and they are sandy, or consist of gravels, giving a poor soil. In the north, clay lands, called gum lands, are also poor ; here large quantities of kauri gum have been dug up from the soil, showing that extensive forests of the kauri pine must have existed on these areas.

The area of plain surface in New Zealand is not large, but the plains are agriculturally the most important districts of the country, the largest being Canterbury plains, on the eastern side of South Island. The plains consist of material brought down from the mountains by the rivers.

The coasts provide comparatively few harbours, and little shelter to shipping. They are generally not steep, and fringed throughout great distances by sand or gravel beaches.

The rivers of New Zealand are not large, owing to the limited size of the islands, especially in breadth. In South Island, the main watershed is comparatively close to the west coast, so that the rivers flowing to the east have much longer courses than those running to the west, the latter being generally mountain torrents. In North Island, owing to the lesser height of the mountains, the rivers have generally more gentle grades.

There are three classes of lakes, those of the glaciated district, the volcanic country, and lagoons near the sea coast.

Great differences seem to exist as regards the stratigraphical geology of New Zealand. Schists, sandstone and shales are the principal mountain rocks of the country. The oldest rocks are found in the south-west of South Island and in Stewart Island; they are gneisses.

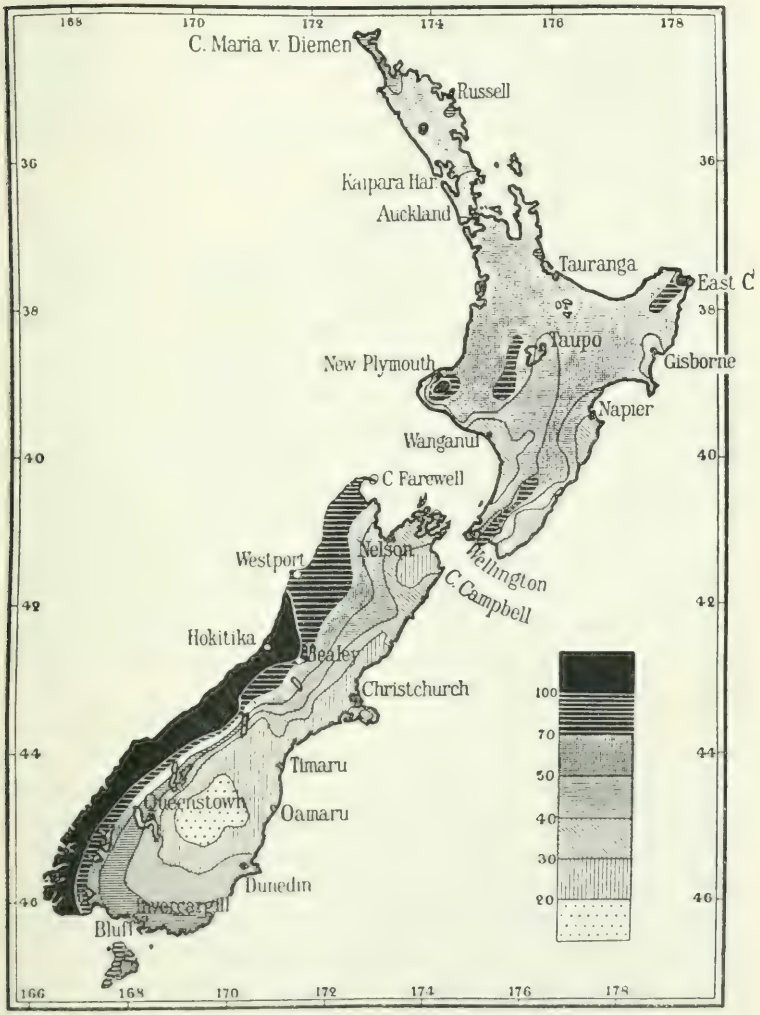
2. Climate.

The main features of the New Zealand climate are the equable temperature due to insular position, the uniform rainfall at nearly all seasons of the year, and the large amount of sunshine. At the same time, there are considerable differences in the several parts of the Dominion, due to latitude, elevation above the sea, the local configuration of the country, the prevailing winds, &c. The mean annual temperature of Auckland is given as 59 degrees, and that of Dunedin, which is 13 degrees further south, as 50, a difference of 9 degrees, due to the difference in latitude. The temperature at Wellington, situated about half way between the other two stations, is given as 55. The difference between the east and west coasts is small, and those between the mean maxima and minima are much smaller than those prevailing in England.

The rainfall seems to be much affected by a succession of cyclones travelling from west to east. Nearly all parts of the

country receive a supply of rain sufficient for agricultural purposes. Droughts of any severity are unknown. Only in parts of Canter-

Fig. 12.



Mean Annual Rainfall, in inches.

bury plain and in central Otago is the rainfall occasionally insufficient to ensure a good yield from the crops. The actual amount of rainfall differs considerably. It is heaviest on the west coast

of South Island, where it rises in some of the mountain valleys, to 200 inches and more. After the crest of the range has been passed, the rainfall rapidly diminishes to less than 30 inches near the east coast. In central Otago, a certain area receives only 15 to 20 inches. In North Island the rainfall is more equally distributed, the greater portion having a fall of between 50 and 70 inches. Near the great volcanoes it is much heavier. On the whole, there can be no doubt that the climate of New Zealand is of a decidedly favourable character.

3. Vegetation.

The general character of the indigenous vegetation is distinctly semi-tropical, and the forest in particular is almost impenetrable in its native state, owing to the large number of lianes, which interlace and form an almost continuous mass of vegetation. Three-quarters of the indigenous plants are absolutely confined to New Zealand, and the difference between the plants of New Zealand and those of Australia is specially striking, considering the proximity of the two countries. There are over 100 species of timber trees, amongst which conifers are prominent. Only about a dozen species of trees are at present of real economic importance. Most of these are believed to be of very slow growth, an assertion which is rather surprising, considering the very thriving character of the climate. As a consequence, numerous exotic trees have been introduced.

4. Population.

The Maoris are the native race, which the first European explorers found in occupation of the islands. As a race, they take a high place among the coloured people of the world. The present Maori population, inclusive of half-castes living as Maoris, is under 50,000, the greater part of them being found in North Island, especially in the centre and northern part of it. Since British sovereignty was proclaimed, in 1840, many immigrants have come from Britain and some from the continent of Europe. Apart from the Maoris, the population, according to the census of 1911, amounted to 1,008,468, or about 10 to the square mile. It had increased during the previous 10 years by 31 per cent., and it seemed probable that, but for the war, the population would

have been doubled in about 35 years, a circumstance which must be considered in estimating future requirements.

5. The Government.

The Governor is appointed by the Sovereign. The General Assembly, being the collective name for the Legislature, consists of the Governor, the Legislative Council, and the House of Representatives. The Statutes of New Zealand are enacted by the General Assembly. The members of the Legislative Council are appointed by the Governor, on the recommendation of the Ministers. The House of Representatives consists of 80 members, of whom 76 are elected by constituencies termed European electorates, and four are elected by Maori electorates. All male and female adults are entitled to registration on the electoral roll of their district. Any male person on a roll of any electorate is eligible to be elected a member of the House. Since the institution of the National Government the Executive consists of thirteen Ministers. The mode of Government is representative; the Governor acts only on the advice of his Ministers. Local Government extends throughout the Dominion. The number of local Government institutions is large.

6. Economic Conditions.

New Zealand has passed through many industrial phases. About 100 years ago, it was the centre of the Southern Pacific whaling and sealing industry. It was also noted then for its gigantic kauri pine trees and the timber which they yielded. When the Australian gold digging industry was at its height, New Zealand supplied the diggers with agricultural produce. Pastoral pursuits began in the forties of last century. From 1861 to 1867 the gold industry flourished. After that had begun to languish the production of wool and tallow were developed. About the year 1870 the growing of wheat commenced. In 1882 the export of frozen sheep and cattle began, and with it commenced New Zealand's prosperity. Now the exports of frozen meat represent an annual value of some 6 million pounds sterling. To this is added the production of butter and cheese, and through it the development of small holdings. Of late years, attention has been given to fruit culture.

A considerable development of industries has taken place ; they are classified under 26 heads. Of these the forester is specially interested in the establishment of timber and paper mills, and the kauri gum industry, the produce of former extensive forests of kauri, *Agathis* (*Dammara*) *australis ;* the gum is dug out of the ground, and its annual value is about half a million pounds sterling. On the whole, however, pastoral and agricultural pursuits overshadow all other industries, the number of sheep alone being about 24 millions. There are considerable mineral deposits, but, with the exception of gold during a short period, the cost of labour is against the development of the mining industry. Coal is found throughout New Zealand, and also oil in some quantity.

The available water power is unrivalled, and will, no doubt, be developed as time goes on. Of railways, 2,800 miles exist at present, and new lines are under consideration. Roads have been greatly developed all over the islands, as well as telegraphs and telephones.

SECTION II.—THE FORESTS OF NEW ZEALAND.

1. Area and Ownership of the Forests.

In the early days of the Colony, the greater part of North Island was covered with dense forest, and also the western part of South Island, while the greater part of the latter was open country. Stewart Island is practically all forest, even now. Fires and extensive saw milling have much reduced the area under forest. In 1886 it was 33,120 square miles ; in 1909 it was 26,678, a reduction of 23 per cent. in 23 years ! The allotment of areas is as follows :—

		Square Miles.		Per cent. of Total Area.
Land under Cultivation .		27,521	..	27
State Forests . .	15,655		..	15
Private Forests . .	11,023		..	11
Total Forests .		26,678	..	26
Other Land . .		48,713	..	47
Grand Total . .		102,912	..	100

Of the State forests, 3,298 square miles are National Parks and Permanent Reserves.

2. Types of Forest Growth.

There are about 100 species of forest trees, amongst which conifers are well represented. Some of the species appear in pure woods, but, as a rule, the forests are of a mixed character, and the stocking is very uneven. As yet only a limited number of species are marketable, of which the following are important :—

(1) *Kauri*, *Agathis* (*Dammara*) *australis*, now found only in small quantities in the Auckland district of North Island. It is the finest tree of New Zealand, and it yields one of the most valuable coniferous timbers of the world. It is to be regretted that this splendid tree was not regenerated instead of being almost exterminated.

(2) *Totara*, *Podocarpus Totara*, has, owing to the quality of its timber, been much reduced in quantity by milling ; what remains now is chiefly found in the Auckland and Wellington districts. It is to be hoped that it will not share the fate of the kauri. There seems yet to be time to regenerate it systematically.

(3) *Matai*, *Podocarpus spicata*, is found in most localities ; it yields a valuable timber.

(4) *Rimu*, *Dacrydium cupressinum*, red pine, found universally in New Zealand, is consumed in greater quantity than any other timber, though not as durable as the above-mentioned species.

(5) *Kahikatea*, *Podocarpus dacrydioides*, white pine, found all over the islands ; it is particularly valued for butter boxes and packing boxes generally.

(6) *Puriri*, *Vitex lucens* (*littoralis*), is the strongest and most durable of the broad-leaved trees of New Zealand ; it is much used for railway sleepers.

(7), (8), and (9) *Three species of Beech*, commonly called birches in New Zealand, namely : Red beech, *Nothofagus fusca ;* black beech, *N. Solandri ;* silver beech, *N. Menziesii*. They are chiefly found in the upper parts of the forest area, and they are gradually coming into use, especially *N. fusca*, principally for fencing and mining.

Various other species are used in small quantities for milling, and more extensively for farming purposes and as firewood.

Of other forest products "Kauri gum," which is dug out of the ground, where formerly extensive kauri forests existed, is of importance.

3. Relationship of the State to the Forests.

Legislation.—A State Forest Act was passed in 1908. As it proved inefficient in some respects, the shortcomings were made good by section 34 of the War Legislation and Statute Law Amendment Act, 1918. The account given in the New Zealand Statement is not very clear, but the present position seems to be somewhat as follows. The Forest Act of 1908 provided, amongst others, powers for :—

(1) The appointment of one of the responsible Ministers to be "Commissioner of State Forests."
(2) The setting apart of any Crown forest lands as State Forests.
(3) The provision of the necessary funds.
(4) The granting of Licences to cut timber in any State forest.
(5) The appointment of forest officers.
(6) The promulgation of Regulations dealing with the duties of Conservators of Forests, the general system of management, protection against fire, waste and other damage, the construction and maintenance of roads and other means of transport, &c., and generally to carry out the provisions of the Act.
(7) The establishment of schools of forestry and agriculture.
(8) The exclusion of open lands from State forests, provided Parliament does not object.

It appears that additional power has now been given to declare any Crown lands "Provisional State Forests," and to permit the Government to take back such areas for settlement purposes ; in other words, to substitute the Government in power at the time for Parliament.

Administrative Methods.—It has been stated above that 3,298 square miles of State forests have been declared National Parks and Permanent Reserves. These consist of climatic and scenic reserves. They may yield a small amount of timber, but that is not taken into account when dealing with the supply of timber generally. The latter is expected to come from the unreserved 12,357 square miles of State forests, private forests,

plantations and imports, at any rate for some time to come. The main classes of timber required at present and in the immediate future are :—

(*a*) Coniferous timbers for building and general purposes.

(*b*) Hardwoods (Eucalypts) for all purposes where stronger and more durable timber is required.

(*c*) Timber for the carriage of agricultural and other produce (butter boxes, &c.), for wood pulp, &c.

For the supply of such material the unreserved indigenous forests are arranged in classes according to the degree of their fitness for immediate or future milling. What is not obtained in this way is imported, conifers from America and the Baltic, and Eucalypts from Australia. As to the questions of replacing what has been cut, and making the country independent of outside supplies, the opinion is held in New Zealand that the indigenous species are too slow-growing to invest any money on their reproduction. Instead of that, the planting of exotic species was started some 25 years ago. It has been estimated that, to provide for future requirements, it will be necessary to plant an area of 700,000 acres. Of that, about 35,444 acres had been planted by 1919 by the State. In addition, a considerable area has been planted by private proprietors. Since some 50 years ago the Government has encouraged private planting, but already, in 1896, it became evident that State planting must be started if the programme was to be carried out. It is evident that State action must be considerably speeded up if 700,000 acres of plantations are to be established within a reasonable number of years. Before the war the cost of planting, including nursery work, came to about £8 per acre, but it is now very considerably higher.

The Forest Authority.—The Ministerial head of the Department is the Commissioner of State Forests, under whom the Superintendents of Nurseries and Plantations worked since the commencement of the operations in 1896. Owing to the rapidly dwindling forest resources, a separate Department of Forestry was at last established in 1919, and placed under a Director of Forestry, who will have the assistance of Research officers, Inspectors and other staff, the whole being under the Commissioner of State Forests as before.

Education and Research.—Nothing seems to have been done so

far for education. As regards research it should be stated that the structure and qualities of the principal timbers have been investigated at the Imperial College of Science and Technology, South Kensington. During the last year or two considerable controversy as to the rate of growth of indigenous trees, as compared with that of exotic trees, has taken place, but the information so far available does not permit any definite conclusions being drawn. It is, however, a subject which should receive early attention by the new Department of Forestry.

State Assistance given to Forestry.—This consists chiefly in providing plants to private proprietors at a low rate, and, in some cases, free of charge, especially to discharged soldiers. About half a million plants were thus provided in 1919.

No information has been supplied in the official Statement, as regards increment, utilization, consumption, export, import, &c.

SECTION III.—SUMMARY AND OUTLOOK.

From what has been stated it is evident that no summary based on official communications can be given, but some remarks on the general policy seem justified.

What strikes the reader at once is the fact that the indigenous forests have practically been thrown overboard, and that future supplies are to be provided from plantations consisting of exotic trees. This is certainly a very bold measure, which the New Zealand authorities seem to have adopted, because they believe that the growth of the indigenous species is too slow in comparison with that of certain exotic species. The questions here involved are :—

(1) Whether the growth of the indigenous species of New Zealand is really as slow as is believed ?

(2) Whether the selected exotic species yield timber of sufficient quality to replace the indigenous species and yet grow much faster ?

(3) Whether it is safe to introduce exotic species on this large scale without risking the development of disease which may lead, in the end, to disastrous results ?

These are questions which require the immediate attention of the newly established Department of Forestry, and more particularly the third question. Indeed, investigations made during

the last 2 years seem to show, for instance, that the growth of kauri is much more rapid than has been supposed. That species yields one of the best coniferous timbers on the earth, and its re-establishment in New Zealand on a considerable scale seems highly desirable. The nature of the New Zealand flora is so distinctly special that the introduction of exotic species is rather risky. No doubt, Oregon Douglas grows very rapidly during youth, but it is also known that its rate of growth falls off considerably with advancing age. Nor does it seem to have been realised in New Zealand that the Oregon Douglas timber imported into New Zealand is taken from trees which were at least 150 years old, and that the Douglas timber produced in New Zealand is not likely to show the same quality unless the trees are allowed to reach a similar age.

On the whole, it appears, as far as can be judged from a distance, that the best indigenous forests should, with due consideration of the requirements of land for the extension of agricultural pursuits, be selected and converted into permanent State forests, properly organised and managed for the sustained supply of indigenous timber. As a consequence, the enormous outlay on plantations can be correspondingly reduced.

Since the above was written a report, by the new Director of Forestry, has come to hand showing that, after many years of a vacillating policy, a new era has commenced which is likely to see the institution of systematic forest management resting on a scientific basis. Above all, it has at last been recognised that the preservation and systematic management of the indigenous forests on the principle of a sustained yield is the first and foremost duty of the re-organised Forestry Department. Full details cannot yet be given, but the general lines of the future forest policy may here be put down. They are :—

(1) Permanent dedication to forest management of all Crown lands chiefly valuable for forestry and timber production with the deletion of all lands chiefly valuable for agricultural purposes.

(2) Scientific forest management of all State forests on the principle of a sustained yield for the benefit of future generations, as well as the present.

(3) Establishment of protection forests at the headwaters of streams, in water-supply basins, &c.
(4) Efficient protection of the State forests.
(5) Establishment of an efficient staff for the Forest Service.
(6) Establishment of a School of Forestry and promotion of Research.
(7) Extension of State planting on suitable lands for local wants.
(8) Decentralisation of the staff and a sound produce-sale policy.

This policy has been well received by producers, consumers, and the general public.

THE CROWN COLONIES AND PROTECTORATES.

I. CYPRUS.

1. Notes on Topography and Climate.

The Island of Cyprus is situated between the 34th and 36th degrees north latitude, and between the 32nd and 36th degree east longitude. It has an area of 3,584 square miles, and a population of about 274,000, or 77 to the square mile.

Topography.—The main feature is a central plain running due east and west from one end to the other, which is bound on the north and south by mountain ridges. The central plain, Messaoria, is alluvial. The northern mountain system, called the Kyrenia Range, is nearly all a limestone formation. The southern, or Troodos System, is generally of igneous composition.

The Climate varies considerably. At Nikosia in the central plain, the temperature varies between 31 and 104 degrees; on Troodos, at 6,406 feet elevation between 46 and 86 degrees during the summer months, while during winter the more elevated parts of the system are snow-clad. The rainfall at Nikosia and in the central plain generally is 14 inches, and somewhat more at the higher elevations. The greater part of the rain falls during the months of November to April; the summer rainfall is insignificant.

2. Main Types of Forest Growth.

In the northern range the forest in the upper parts consists of *Pinus halepensis* (Aleppo pine) mixed with *Cupressus sempervirens*

and with shrubs, the most marked of which are *Pistachia terebinthus* and *lentiscus*, and *Arbutus andrachni*. The lower slopes are mostly covered with *Juniperus phœnicia*. Aleppo pine grows slowly and does not attain any great height. The cypress grows quicker and its timber is good.

The forests on the southern range are, up to 3,000 feet, almost pure Aleppo pine of good growth, yielding timber of good quality. The Troodos forest above 3,000 feet is nearly pure *Pinus nigra var. Laricio*, except on the upper slopes where there is a quantity of *Juniperus fœtidissima* with some specimens of *J. oxicedrus* and *Quercus alnifolia*.

In the centre of the Paphos forest is about a square mile of good specimens of *Cedrus libani var. brevifolia*, of slow growth. *Quercus alnifolia* is distributed over considerable areas. In moist ravines *Platanus orientalis* and *Alnus orientalis* are found. Fine specimens of *Quercus infectoria*, *Pfœffingeri* and *inermis* are also found, which are jealously guarded for the acorn crop.

The important timbers are obtained from the species mentioned above. In addition may be mentioned *Laurus nobilis*, *Styrax officinalis* and *Juglans regia*.

3. Area and Ownership of the Forests.

	Square Miles.	Per cent. of Total Area.
State Forests :		
For timber production	651	93
Other forests	49	6
Total State forests	700	99
Corporation forests	4	1
Private forests	1	—
Total forest area	705	100

4. Relationship of the State to the Forests.

Legislation.—Under special forest legislation, and under the general law, the State has complete control over the forests. The cutting of timber and grazing are said to be regulated. As regards fire protection, 485 miles of paths have been cut, so as to enable labourers to get to the fires in case any should start.

Some planting was commenced in 1889, and again in 1904, on drift sand and dry rocky waste ; the areas are now for the second time being cut over for fuel. In 1918—1919 about 8 square miles were sown and partly planted, but it is not stated with what species.

The natural regeneration of the existing forests is poor, owing to the unfavourable climate. Seeds germinate freely, but it is said the drought of summer kills the seedlings off again. Possibly the large herds of goats, which graze in the forests, do more damage than the summer drought.

Seedlings of various forest trees are distributed to villagers who desire to plant, and advice is given to private persons. The Forest Authority consists of a Principal Forest Officer and an Assistant, with a staff of Cypriot officials of various grades. The Forest Department is allowed independent action subject to a general responsibility to the Government. The recruitment is entirely local ; no educational work is undertaken by the Department.

5. Increment and Utilization.

No estimate of the annual increment of the forests has been attempted. The utilization in 1918—1919 is given as follows :—

	Cubic feet.	Valued at, £.
Timber . .	123,388	6,170
Firewood . .	2,451,050	24,510
Total .	2,574,438	30,680

6. Forest Industries.

Forest industries are at present confined to lumbering and fuel preparation. It is stated that various other industries are capable of development, such as wood distillation, essential oils, sumach (*Rhus cotinus*), schinia (*Pistachia Lentiscus*), ladanum gum (*Cytisua Creticus*), dyes, bay rum from the fruit of *Laurus nobilis*, &c.

7. Exports and Imports.

There is, apparently, no export of timber, but an import valued at £21,665 ; also of a small amount of firewood, charcoal, pitch and rosin.

8. Summary and Outlook.

The available data are not sufficient to prepare a general summary of home consumption, but it is stated that the mature timber in the forests is roughly estimated at 14,000,000 cubic feet, the present consumption about 190,000 cubic feet, and that the available stock will suffice for the next 73 years. The local authorities are also of opinion that the annual growth exceeds the annual consumption. At the same time it is said that to protect and develop the forest resources the following measures are essential :—

(1) The abolition of goats and prohibition of all grazing.
(2) Systematic and efficient fire protection.
(3) Artificial re-afforestation, not only of the areas cut over or burnt, but also of waste areas, of which there are about 300 square miles fit to produce Aleppo pine.

As a fourth measure may be mentioned the opening to traffic of many forests which appear to be at present inaccessible.

J. CEYLON.

1. Notes on Topography and Climate.

Ceylon is situated between the 6th and 10th degree of northern latitude and the 79th and 82nd degree of eastern longitude. It has an area of 25,500 square miles and a population of 4,100,000 people, giving 161 to the square mile.

Topography.—Ceylon has the shape of a pear, the northern point of which almost touches the southernmost point of India. There is a high tableland in the south-eastern part of the island rising abruptly to 4,000 feet elevation ; it is divided by a higher ridge running south to north, the highest peak of which rises to 8,000 feet above sea level. From the high plateau spurs run in several directions, which only exceptionally attain a height of 3,000 feet. Apart from these spurs, the country to the south and west of the plateau presents a series of low rocky ridges separated by wide valleys, and gradually levelling down to the sea. To the north and east of the tableland, comprising about three-fourths of the island, the country consists of an undulating jungle-clad plain, out of which rocky gneiss peaks rise abruptly.

The prevailing rock is gneiss, which on decay gives a clay soil of considerable depth. In the gneiss, bands of hard crystalline magnesian limestone are common. Alluvium is found in all the larger valleys. In the north, the Jaffna Peninsula is post-tertiary, consisting of marine limestone. Graphite is mined in the south-west, also gem stones. There is no coal.

Soils are mostly gravelly and shallow, but in the wet zone, and especially in valleys, they are often rich and deep. They have been much impoverished by long continued shifting cultivation. Rich soil eminently suited for agriculture is still found in Jaffna.

The Climate is greatly influenced by meteorological phenomena in South India. There is no definite summer and winter, any differences being due to the monsoons. During May to September south-west winds prevail, and from October to April north-east winds, rain coming from both directions. During the south-west monsoon the mountain zone and the south-west of the island get most of the rain, while the plain to the north and east is dry and hot; during the north-east monsoon the eastern lowlands are watered and also the mountains. The rainfall varies between 20 and 200 inches; the driest parts are situated in the north-west and south-east.

2. Main Types of Forest Growth.

Ceylon foresters distinguish three main zones :—

(1) *The Mountain Zone* above 4,000 feet, comprising some 4,000 square miles, with a rainfall between 75 and 200 inches. Above 5,000 feet, all forests are reserved, and no alienation of land will be permitted in future, but in the past most of the area has been devastated by tea, coffee and shifting cultivation. During recent years about 130 square miles of forest have been re-established. The zone is divided into two sub-zones :—

(a) *The Mountain Sub-zone proper.*—The trees in this zone have short, crooked and gnarled stems, owing to continued exposure to wind and rain. The prominent species are *Rhododendron arboreum*, *Calophyllum trapezifolium* and *Walkeri*, *Michelia nilagirica*, *Eurya japonica*, *Gordonia zeylanica* and *speciosa*, *Elæocarpus zeylanicus* and other species. *Eugenia revoluta*, *assimilis*, and others; *Sym-*

plocos spicata and small bamboos. Conifers, Eucalypts and Australian wattles have been introduced into this zone. The most successful of these exotics are *Cupressus. macrocarpa* and others. *Pinus insignis* and *longifolia, Eucalyptus robusta, Globulus, pilularis, siderophloia* and *diversicolor ; Acacia Melanoxylon, decurrens* and *dealbata*, and *Cedrela serrata.*

(b) *The Patana Sub-zone* consists of grassland with here and there stunted trees ; it was formerly forest, but it has been destroyed by shifting cultivation, grazing and fires.

(2) *The Wet Zone* comprises the south-west part of the island and the foothills up to 4,000 feet. It is divided into two parts :—

(a) *The Endemic Sub-zone* with a rainfall of 100 to 200 inches. The forests in this sub-zone are the finest in Ceylon. Their distinguishing features are the plentiful representation of species of *Dipterocarpus, Shorea Doona, Hopea, Balanocarpus, Vatica* and *Vateria.* There are a great variety of other trees belonging to the *Dilleniaceæ, Guttiferæ, Celastraceæ, Sapindaceæ, Anacardiaceæ, Leguminosæ, Myrtaceæ, Rubiaceæ,* and others, palms, tree ferns, bamboos, &c. Great inroads have been made into these forests for the purpose of planting rubber, tea, cinnamon and coconuts. They used to contain Coromandel wood (*Diospyrus quæsita*) which is now almost extinct, while other excellent furniture woods are rapidly disappearing.

It may seem at first sight that to replace the natural forest by products of a greater commercial value is reasonable, but these operations in Ceylon have resulted in great damage, inasmuch as they have been followed by erosion on an immense scale and the silting up and periodic flooding of the low country, together with the destruction of arable lands and other property. Moreover, the planting operations have not always been successful, and from large tracts of abandoned lands the soil has been utterly washed out. These areas are now covered with bamboos, useless shrubs and rank grasses. Similar destruction has been brought about by shifting cultivation.

(b) *The Intermediate Sub-zone* is a narrow strip of country more or less surrounding the endemic sub-zone. Rainfall,

75 to 100 inches. It contains species from both the wet and dry zones.

(3) *The Dry Zone* comprises two-thirds of the island with about three-fourths of its forests. It has been divided into the following sub-zones :—

(a) The Arid Sub-zone consists of two strips, one in the south-east and the other in the north-west. Rainfall, 20 to 50 inches. Forest growth patchy and stunted, representing scrub and low jungle. The only species which reach tree size are *Elæodendron glaucum*, *Mimusops hexandra* and *Hemicyclia sepiaria*.

(b) *The Dry Sub-zone proper* is the largest in the island. Rainfall 50 to 80 inches. The forest varies very much from scrub to inferior low forest and to high forest. The two former forms occupy the greater part of the area. The high forest contains most of the valuable species. The scrub and inferior parts are the result of long continued shifting cultivation (*chena*). The forest growth is generally evergreen ; it is dense, but the trees seldom exceed 40 feet in height. The percentage of valuable species is low. The most noteworthy species are *Chloroxylon Swietenia*, *Diospyros Ebenum*, *Pleurostylia Wightii*, *Mimusops hexandra* and *Elengi*, *Berrya ammonilla*, *Vitex altissima* and several additional species of *Diospyros*. The *Dipterocarps* have practically disappeared, but *Leguminosæ* are well represented by *Cassia marginata*, *Dalbergia lanceolaria*, *Bauhinia tomentosa* and *racemosa*, and several Acacias. Palms are represented by the *palmyra* palm and *Phœnix zeylanica*.

(c) *The Park Sub-zone* represents a savannah forest containing trees like *Terminatia Chebula* and *belerica*, *Anogeissus latifolia*, *Carya arborea*, *Butea frondosa* and rank grass. This class of forest is confined to the eastern province and Uva.

Littoral forests are found in the mangrove swamps with the usual *genera*, *Rhizophora*, *Bruguiera* and *Ceriops*, valueless as timber, but the *Rhizophora* bark is used for tanning. There are also the screw pine (*Pandanus*) and *Heritiera littoralis*. Near the coastal villages the coconut and palmyra palms are cultivated.

3. Area of the Forests.

The following division of the land of the island is given :—

		Square Miles.	Per cent. of Total Area.
Agricultural Land		4,869	19
Forest, Merchantable	4,816		19
Forest, Unprofitable	15,545		61
Forest total		20,361	80
Other Land		251	1
Grand Total		25,481	100

The more accessible areas of the merchantable forests have been considerably over-exploited in the past. Taking this fact into consideration, their area would represent not more than about 12 per cent. instead of 19 per cent.

4. Ownership of the Forests.

	Square Miles.	Per cent. of Total Area.
State Forests for Timber Production	4,216	21
Other State Forests	11,299	55
Total State Forests	15,515	76
Corporation Forests	4,682	23
Private Forests	164	1
Total Forest Area	20,361	100

The Corporation forests belong to Buddhist Temples and to the municipalities of Colombo, Kandi, Galle, Nuwara, Eliya and Ratnapura ; the private forests belong to Native Chiefs and Planters.

The area of State Timber forests includes 8 square miles of plantations, planted chiefly with teak in the low country, and with Eucalypts, *Acacia Melanoxylon* and a few conifers in the mountains.

5. Important Forest Produce.

There are about 60 important species of timber trees, most of which have been mentioned above. In addition, a number of

exotic species have been planted, of which the following may be mentioned :—

(1) Teak (*Tectona grandis*) grows well and rapidly.

(2) *Swietenia macrophylla* and *Mahogani*, of which the former does well and the latter fairly well.

(3) *Cedrela serrata* (Cedar wood, or Toon) grows rapidly, but suffers from insect attacks.

(4) *Eucalyptus rostrata*, *Globulus*, *siderophloia* and *maculata* do well at 4,000 feet above sea-level.

(5) *Acacia Melanoxylon*, *decurrens* and *dealbata* grow well.

(6) *Myroxylon Pereiræ*, the balsam of Peru, grows well.

(7) Of Conifers, *Cupressus macrocarpa* is doing very well ; it is now largely planted, yielding a useful soft white wood. Pines are generally unsatisfactory.

The items of other forest products have not yet been sufficiently investigated, but the following may be mentioned :—

(*a*) The fruit of *Terminalia Chebula* and *belerica*, used for tanning and dyeing.

(*b*) The bark of *Cassia auriculata* and of *Rhizophora* for tanning.

(*c*) The bark of *Cinnamomum zeylanica*.

(*d*) The seeds of *Azadirachta indica*, for their oil.

(*e*) *Strychnos nux-vomica* and numerous other medicinal plants.

6. Relationship of the State to the Forest.

Legislation.—Probably in no part of the British Empire have so many attempts been made to do justice to the forests as in Ceylon, but, until quite recently at any rate, there have been no results. It would lead too far to explain here the causes of these failures.

The Ordinance No. 16 of 1907 provides for :—

(1) A Re-declaration of State ownership of all forests, waste, chena, uncultivated or unoccupied lands.

(2) The issue of rules for the protection of all Government lands, for the declaration of Reserves, village forests, the control of timber in transit, the checking of forest offences and the punishment of offenders.

(3) The management of the reserves by the Forest Department.

(4) Rules drawn up to control shifting cultivation (*chena*), which, however, have not been properly enforced up to date.

Development of Forest Management.—No efficient plan of forest conservancy has yet been drawn up, but a conference is about to be held for the purpose of attending to the matter. In the meantime some improvement has taken place during the last few years, more particularly in the way of bringing chena cultivation under control, in introducing a more efficient system of fire protection, in assisting natural regeneration to some extent by artificial sowing and planting.

The Forest Authority.—The chief forest authority is the Conservator of Forests, who is assisted by 14 Deputy and Assistant Conservators and 3 Extra Assistant Conservators; there is a subordinate staff of 230 Foresters, Guards, &c. The island is divided into 11 forest Divisions which coincide with the Revenue Administrative Divisions, each in charge of a superior forest officer.

Education and Research.—There is no forest school in Ceylon. The members of the superior staff are expected to hold the Oxford University Degree or Diploma in Forestry. Candidates for rangerships must have a fair education; they are taken on probation for some time, and, if satisfactory, sent to the Forest School of Coimbatore in Madras, for technical instruction. Extra Assistant Conservators are usually deserving men from the subordinate staff.

So far no encouragement has been given to research, but it has been recognised that a research institute is urgently required for botanical, zoological and economic investigations.

Income and Expenditure.—The averages for the 5 years 1914—1919 were :—

	£
Revenue	91,737
Expenditure . . .	35,286
Surplus . . .	£56,451

7. Forest Activity of Corporations and Private Owners.

There is practically none. The Temple forests are under chena cultivation, and the municipal forests are held as catchment areas for the water supply.

8. Increment and Utilization.

Of the increment only an estimate can be given, based on the measurement of some sample areas; it is as follows:—

	Cubic Feet.
Increment on 5,000 square miles of State forests, Timber	8,239,000
Loss by fire, decay, waste, &c.	7,626,890
Net Increment	612,110

Very large quantities of fuel are produced, the figure for which cannot be given.

The Annual Utilization is stated to be as follows:—

Timber from State Forests:

Type of Timber.	Quantity, cubic feet.	Value, £.
Ebony	3,637	1,387
Satin wood	4,860	3,822
Other timbers	822,570	56,368
Total Timber	831,067	61,577
Fuel estimated at	14,799,000	32,867
Minor Produce	—	18,806
Total Value of Produce	—	113,250

The minor produce consists of numerous articles, such as tanning bark, gallnuts, mirobolans, the fruit of *Strychnos nux-vomica*, honey, &c. Figures for oils, gums, fibres, dye-woods, &c., are not available.

9. Forest Industries.

The largest industry is the manufacture of tea and rubber chests, in which about 300,000 cubic feet of timber are used annually. The work is done chiefly by village carpenters; as they are time workers it is difficult to reduce them to full-time workers. Basket making and cane weaving employ a large number of people, and so do furniture making, coopering, boat building. The collection of minor produce employs about 1,000 people.

10. Exports and Imports.

The following data represent the average of the last 10 years :—

	Quantity, cubic feet.	Value, £.
Exports	436,880 ..	25,413
Imports	541,262 ..	79,407
Surplus, Imports over Exports	104,382 ..	53,994

The exports comprise small quantities of ebony and satin wood, while the imported timber is chiefly teak.

11. Summary and Outlook.

	Cubic feet.
Utilization . . .	831,067
Less Exports . . .	436,880
	394,187
Add Imports . . .	541,262
Home Consumption . .	935,449

The utilization exceeds the increment by 218,957 cubic feet, while the home consumption exceeds it by 323,339 cubic feet. This represents a very unhealthy condition. There is not one year's supply of conifers in the country ; even the supply of hardwoods is running short.

The Government of Ceylon has repeatedly expressed the desire to take up real forest conservancy, but the results have been very poor. The bulk of the forests have been destroyed chiefly by shifting cultivation, fires and improvident exploitation. A definite forest policy should be laid down without delay and carried out. In doing this, the following points should receive special attention :—

(1) The establishment of an area of permanent State forests sufficient to meet future requirements.

(2) Management of these State forests according to working plans drawn up on the basis of a sustained annual yield.

(3) Development of the natural regeneration of the natural forests where this is still possible, supplemented by sowing and planting wherever necessary.

(4) The establishment of at least 20,000 acres of soft woods stocked with suitable conifers, *Melia dubia* or other suitable species.

(5) Thorough protection of the permanent State forests at any rate, against chena cultivation, fire, &c.

(6) Development of the system of roads and other means of transport.

(7) The setting up of a staff capable of dealing with the efficient carrying out of the scheme, and research in important questions.

K. THE MALAY PENINSULA.

1. General Notes on the Country.

The Malay Peninsula is situated between the 1st and 7th degree northern latitude and the 100th and 105th eastern longitude. It is divided into the following three parts :—

	Area, Square Miles.	Population.	Density, per Square Mile.
(*a*) *The Straits Settlements*	1,660	700,000	423
(*b*) *Federated Malay States*	27,500	1,000,000	36
(*c*) *Unfederated Malay States*	24,800	800,000	32
Total	53,960	2,500,000	46

The Settlements are : Singapore, Malacca, Dindings, Penang and Wellesley. The Federated States comprise : Sembilan, Negri, Selangor, Pahang and Perak. The Unfederated States are : Johore, Trengganu, Kelantan, Kedah and Perlis.

Topography.—The peninsula is generally undulating or hilly, and the central mountain mass rises to over 7,000 feet above sea level. The slopes of the hills are usually steep. There are no elevated plateaux of any importance, but considerable areas of alluvial plains in Kedah and within some miles from the sea. The rivers are, as a rule, shallow and suited only to traffic by small native craft and steam launches. There are no lakes of importance.

Geology and Soil.—The rocks are mainly granite, quartzite with imbedded shale, and crystalline limestone ; the latter form isolated hills with precipitous sides. The intensity of the tropical weathering produces sufficient soil over the rocks to support a

luxuriant flora. In the granite areas weathering goes down deep, and in consequence on steep slopes serious landslips easily occur, especially after heavy rain.

Climate.—The temperature is equable; at sea level it ranges between 70 and 90 degrees, with an average of 80. The rainfall averages about 100 inches, but it varies much, being heavier in the hills than on low ground. There is not much seasonal difference in this respect. Snow and frost are unknown.

Communications.—The settlements and the Federated States have a good system of roads, except Penang. There are 3,000 miles of metalled roads and 949 miles of railways.

2. Types of Forests.

With the exception of a few areas in Kedah, the forests are evergreen. A distinction is made between littoral and inland forests.

Littoral Forests.—Mangrove swamps cover over 300 square miles, chiefly on the west coast; they consist of species of *Rhyzophora, Bruguiera, Ceriops, Avicenia, Heritiera, Afzelia* and also *Nipa fruticans.*

Casuarina equisetifolia is found in belts on sand near the coast; it reproduces itself naturally and grows very rapidly, reaching a height of 120 feet and a girth of 4½ feet. Other coast forests contain *Hibiscus tiliaceus, Pongamia glabra, Calophyllum inophyllum, Terminalia Catappa* and occasionally *Podocarpus polystachyus.*

(1) *Inland Forests.*—Fresh Water Swamps contain species of *Shorea, with* Screw pine (*Pandanus sp.*) in the underwood.

(2) *Dry Forests.*

(*a*) The Lowland forests frequently contain more than 50 per cent. of Dipterocarps. There are over 100 species of this family in Malaya; the best known genera are *Hopea, Shorea, Vatica* and *Petacme.* The most important trees are *Shorea materialis, collina* and *glauca. Hopea Lowii,* Borneo camphor (*Dryobalanops aromatica*). Other species of importance are *Payena utilis, Eugenia spp.,* several *Lauraceæ, Afzelia spp., Mesua ferrea,* Gutta-percha (*Palaquium oblongifolium*), &c. The Dipterocarp forest is most imposing; the top story averages 100 feet high with single trees up to 200 feet, and a thick undergrowth.

(*b*) The High Hill Forests are at present of little importance. They are of much smaller height; their object is to prevent erosion and to regulate the flow of water. Dipterocarps do not appear in them, but there are some conifers, *Agathis alba* and *flavescens*, *Dacrydium spp.*, and *Podocarpus latifolia*, *neriifolia* and *Wallichianus*.

3. Area of Forests.

A moderate time ago probably the whole of the peninsula was covered with forest. The present disposition of the land is as follows :—

		Square Miles.	Per cent. of Total Area.
Agricultural Land		8,200	16
Forests Merchantable	21,166		39
Forests, Unmerchantable	14,100		26
Total		35,266	65
Other Land		10,494	19
Grand Total		53,960	100

Owing to an extensive alienation of land for the cultivation of rubber and for other purposes, the forests situated in the parts of the country with the best means of communication are badly distributed, and difficulties have already been experienced in parts of Perak and Selangor in supplying the demand for fuel for railways, mines and rubber factories.

4. Ownership of the Forests.

The following data show the ownership :—

	Square Miles.	Per cent. of Total Area.
State Forests :		
Straits Settlements	266	0·75
Federated States	21,000	59·55
Unfederated States	10,500	29·77
Total State forests	31,766	90·07
Corporation Forests	2,500	7·09
Private Forests	1,000	2·84
Total forest area	35,266	100·00

5. Important Forest Produce.

More than one-half of the commercial timber of the country is produced by the Dipterocarps. Other woods of special value are species of *Calophyllum*, *Eugenia*, *Artocarpus*, *Afzelia*, *Mesua ferrea* and various others. For firewood the most highly prized woods are the Mangroves.

The principal items of minor produce are Canes, Gutta-percha and Dammar. The most important commercial canes are *Calamus cæsius*, the *Rotan sega*, and the Malacca cane (*Calamus Scipionum*). In 1919 the revenue on canes was about 20,000 dollars, while the value of the canes was at least 10 times that amount. Canes to the value of 2½ million dollars were imported into Malaya in 1918, cleaned and otherwise prepared in Singapore, and re-exported.

Of Gutta-percha large quantities were formerly produced in the country, but the destruction of the trees has been so great that the present annual output is probably less than 20 tons. Plantations are being formed, and it is hoped that the former supply will gradually be re-established.

Dammar is obtained from the Dipterocarps, especially from *Balanocarpus spp.* About 250 tons were collected in 1919.

6. Relationship of the State to the Forests.

Straits Settlements.—An Ordinance, No. 22, was passed in 1908, drawn up on the lines of the Burma Forest Act. It deals with :—

(1) The appointment and powers of forest officers.
(2) The constitution and protection of Reserved Forests.
(3) The levy of royalties on forest produce and its protection in transit.
(4) The procedure in dealing with forest offences.

Under the Ordinance, rules were passed for the administration of the forests.

The Federated States.—Until 1914 each State had its own forest enactment. In that year the enactments of the four States were combined into a federal enactment, and in 1918 a revised enactment (No. 349 of 1918), which is still in force, was passed by the Rulers of the Federated States in Council. It follows the Burma Act even more closely than the Settlements Ordinance ; under it Rules were made.

The Unfederated States.—In Kedah a forest enactment (No. 6) was passed in 1918, which is a shortened form of the Federated States enactment and rules.

In Johore the Land Enactment of 1910 and rules made under it provide for the reservation of land for forest purposes and for the extraction and levy of royalties on forest produce.

In Kelantan the Timber and Jungle Produce Rules, 1914, provide for the extraction of forest produce and the levy of royalties on it.

In Trengganu the export of Chengal (*Balanocarpus spp.*) is prohibited. With this exception there are no forest rules in this State.

Administrative Methods.—As rain falls every month, the protection of the forests against fire is unnecessary. The planting of waste lands on an experimental scale has been attempted, but so far without success. On the other hand, a considerable amount of planting has been done in blanks in felling areas in the mangrove swamps, and attempts have been made, with varying success, to introduce species of *Balanocarpus*, *Afzelia palembanica* and gutta-percha into forests not containing them. At present the efforts of the Department are chiefly directed to improvement fellings, to assist the saplings and poles and to encourage the natural regeneration of the more valuable species. Special success has been achieved in this way with camphor (*Dryobalanops aromatica*), gutta-percha and certain Shoreas; some 40,000 acres have been treated in this way.

The Forest Authority.—Passing over the earlier attempts at conservancy, a real start was made in 1900, when Mr. H. C. Hill, late Inspector-General of Forests in India, reported on the forest administration in the peninsula. On his suggestion the post of Chief Forest Officer, now called Conservator, was created and filled by a trained and experienced Indian officer, who organized the department. The present staff consists of 1 Conservator, 1 Research Officer, 14 Deputy and Assistant and 6 Extra Assistant Conservators, and a subordinate staff of Rangers, Foresters, Guards, &c., numbering 500 members. An enlarged scale is under consideration.

The Conservator is the administrative head of the Department and the technical adviser to Government in forest matters; he is

also consulted by the Federated States either directly or through his subordinates; he has at present no jurisdiction in the Unfederated States. Each State is in charge of a Deputy Conservator, who is responsible to the Conservator in technical matters; otherwise he is subordinate to the Resident of the State.

Recruitment and Training.—The superior staff has, in the past, been recruited in a variety of ways, but chiefly from Coopers Hill and Oxford. In future it is proposed to appoint as Assistant Conservators only men who have received a thorough training in Europe; Extra Assistants will be recruited from Dehra Dun, or given a local training. The subordinate staff is recruited locally.

Research.—A considerable amount of systematic botanical work has been done; also measurements for statistical work have been commenced. A herbarium has been started. In 1918 a qualified Research Officer was appointed, and since then the study of commercial timbers has made good progress.

Income and Expenditure.—The following figures represent the averages of the years 1915 to 1919 in pounds sterling:—

	Revenue, £.	Expenditure, £.	Surplus, £.
Straits Settlements .	3,927 ..	3,814 ..	113
Federated States .	110,754 ..	68,251 ..	42,503
Total . .	114,681 ..	72,065 ..	42,616

The forests of the Straits Settlements are not likely to prove remunerative for some time to come. Little is at present known as to the potentialities of the forests of the Unfederated States.

7. Private Activity.

There are about 2,000,000 acres of privately planted and owned plantations of Para rubber, and the planting of gutta-percha has also commenced. The difficulty of obtaining fuel for the mines and rubber factories is causing some concern, but no effort has yet been made to meet the situation by the raising of firewood crops.

8. Increment and Utilization.

It is impossible to give any reliable estimate of the increment. The mangrove swamps may produce about 75 cubic feet per acre and year. The inland forests might perhaps produce 25 cubic feet per acre and year of serviceable material. It is estimated

that the waste is almost equal to the annual consumption. During the last 20 years it has certainly been much greater, as at least 50,000,000 tons of timber have been burnt by the rubber planters. On the above lines the following estimate has been prepared :—

Area of merchantable forests under State control	24,166 square miles.
Increment in cubic feet	394,000,000 cubic feet.
Waste	206,000,000 ,,
Net annual Increment	188,000,000

The annual Utilization is estimated at :—

Straits Settlements	75,000,000 cubic feet.
Federated States	150,000,000 ,,
Unfederated States	50,000,000 ,,
Total utilization	275,000,000 ,,

Of this quantity, 25,000,000 cubic feet are timber and the rest is firewood.

9. Forest Industries.

The only forest industry of any importance is lumbering and firewood cutting, whereby some 30,000 people are employed for part of the year. A match factory is under erection at Selangor ; wood distillation is under consideration. Other industries are all on a small scale, such as the collection of dammar and gutta-percha tapping. Canes are extracted under licence. The leaves of *Nipa fruticans* are used for thatching. Other small branches of industry are cart and boat building, charcoal burning, the weaving of mats from species of Pandanus, the tapping of wood-oil trees, &c.

10. Exports and Imports.

The following data represent the annual averages of the years 1913 to 1918 :—

	Imports, £.	Exports, £.	Excess of Imports.
Timber	139,226	19,292	+119,934
Planks	45,083	180,148	—135,065
Firewood	69,467	200	+ 69,267
Charcoal	29,181	2,792	+ 26,389
Totals.	282,957	202,432	+ 80,525

The quantities are not available. Most of the imports of timber consist of teak from Siam. Mangrove firewood, charcoal and Dipterocarp and Sapotaceous timber come from the Dutch East Indies. Exports are mainly re-exports of rough-hewn timber brought into the country for conversion at the Singapore saw-mills. Generally, the imports are increasing and the exports decreasing, pointing to increasing consumption in the peninsula.

The trade in other forest produce is confined to canes, gutta-percha, dammar and mangrove bark, the bulk of which is imported from overseas and re-exported.

11. Summary and Outlook.

As the quantities of imports and exports cannot be given, the summary is reduced to the following :—

	Cubic feet.
The Utilization is equal to . . .	275,000,000
The Net Increment is estimated at . .	188,000,000
The annual Deficit is equal to . .	87,000,000

In this statement the increment refers only to the merchantable forests of the present time ; the total increment of all forests is considerably greater. The local authorities consider, however, that, owing to the continual increase in consumption, the total requirements will soon overtake the total increment, unless the systematic management of the forests is considerably improved.

The matters which require more immediate attention are : -

(1) The declaration of a sufficient area as permanent State forests.

(2) Restriction in alienating forest lands for other purposes. (Fortunately the limit has already been reached as far as rubber planting is concerned, an industry which has been overdone.)

(3) Steps should be taken to prevent the terrible destruction of timber and firewood practised by planters.

(4) Development of means of communication outside the limits of the present merchantable forests, so as to increase the area of merchantable forests.

(5) Introduction into the market of a larger number of species than has been the case in the past.

L. KENYA COLONY.

(See Sketch Map on p. 203.)

Kenya Colony is situated between latitude 4 south and 4 north. It comprises an area of 245,000 square miles and has an estimated population of 2,652,000 people, giving an average density of 11 per square mile.

1. General Notes on the Country.

Topography.—Along the coast on the east a fertile belt 10 to 20 miles wide is found, which comes under the influence of the moisture-laden sea winds. This is followed, on going west, by a belt with an elevation between 600 and 1,500 feet; then comes a good extent of country between 1,500 and 3,000 feet, and the rest of the country is situated at an elevation over the latter height, running up to about 6,000 feet in the north-western part, and a maximum height of 12,880 feet in the south-west. It then drops down steeply into the Rift valley to 6,000 feet and rises again sharply to the Mau mountain on the west and an elevation of 10,000 feet; after that the country drops gradually to 3,300 feet at Lake Victoria.

There are two isolated mountain masses, Mount Kenya, 17,040 feet, on the east of the Rift, and Mount Elgon, 14,140 feet, to the west, only one-half of the latter being within the Colony. To the north, the country falls away towards Abyssinia, being very sparsely watered and assuming the character of a desert.

The slopes of Mounts Kenya and Elgon and of the mountains on either side of the Rift valley are covered with forest which are the most important in the country.

There are no large navigable rivers. Tana and Juba, the two most important, are navigable for shallow draft boats for a few months in the year. The fertile part of the country is watered by numerous small streams which have their sources in the mountain forests or above them.

Climate.—The climate is essentially tropical, there being no marked seasons of summer and winter; the growth of vegetation is limited only by dry weather conditions, and nearly all the trees are evergreen. Apart from elevation, the temperature is equal, and there are no extremes of heat or cold. The mean annual

temperature ranges between 59 degrees at 7,000 feet and 79 degrees at Mombasa on the east coast. Frost is practically unknown below 9,000 feet.

The rainfall is greatest on the west, and gradually diminishes towards the east. The records are not sufficient to give a detailed account of it; at an altitude of 6,600 on the western slope of the Mau mountain the average fall is 76 inches, while it is 43 inches between Nairobi and Kussumu. There are two seasons of rain, from March to May and November to October; to the west of the Rift valley the former extends into August, while the rainfall during the latter is less plentiful.

The mountain forests, situated in the heaviest rainfall areas, play a most important part in the economy of the country; they protect the hill sides against erosion, and they conserve and maintain the flow of water in the streams on which the prosperity of agriculture depends, besides providing fuel, coal and oil not having been found in the country.

2. Main Types of Forest Growth.

These are as follows:—

(*a*) *Mangrove Swamps* on creeks and inlets of the coast, the principal species being *Bruguiera gymnorhiza*, *Rhizophora mucronata*, *Ceriops Candolliana*, *Sonneratia caseolaria*, *Avicennia officinalis*, *Lumnitzera racemosa* and *Heritiera littoralis*.

(*b*) *Coast Forest*, situated in the coast belt under the influence of moist sea winds, formerly covered large areas, but only isolated groups remain now, owing to shifting cultivation. The chief species are *Afzelia cuanzensis*, *Trachylobium Hornemannianum* (Gum Copal), *Combretum Schumannii*, *Tamarindus indicus*, *Berlinia spp.*, *Brachystegia sp.*, *Erythrophloeum guineense*, *Mimusops sp.*

(*c*) *Nyika Forest* covers vast areas of waterless arid country between the coast and the highlands; it consists of impenetrable thorn bush, but near the coast the trees are larger and form real forests of *Acacia spp.*, *Brachylæna sp.*, *Afzelia*, *Dalbergia Melanoxylon* (Ebony), *Cynometra sp.*, and numerous other species not yet identified.

(*d*) *Plains Forest* on small detached areas below the main mountain forest at an elevation between 5,000 and 6,500 feet only on laterite soil, the more important species being *Brachylæna*

Hutchinsii, *Croton Elliottanus*, *Toddalia sp.*, *Rawsonia usambarensis*, *Markhamia Hildebrandtii*, *Drypetes sp.*, *Warburgia ugandensis*, *Strynos spp.*, and others.

(*e*) *Mountain Forests*, situated on Mount Kenya, Mount Elgon, the slopes of the Aberdare mountains, the Mau-Elgeyo mountains and elsewhere. They exceed in area the rest of the forests, and they are divided into two main classes, the Muzaiti and the Cedar forests. They spread from the plains forest up to the bamboo forest above.

Muzaiti Forests occupy a moderate area, but contain a large number of species, many of which attain large dimensions. The most important species are *Muzaiti* (*Ocotea usambarensis*), *Podocarpus milanjianus*, *Pygeum africanum*, *Allophyllus abysinnicus*, *Warburgia ugandensis*, *Cornus Volkensii*, *Olea Hochstetteri* and others.

Cedar Forests are, from a commercial point of view, the most important forests in the Colony; they clothe the hillsides of most of the mountains, and contain a large percentage of the conifers of the country, Cedar and Podo. The chief species are : *Juniperus procera* (Cedar), *Podocarpus milanjianus* (Podo), *P. gracilior*, *Olea Hochstetteri*. These 4 species represent nearly 70 per cent. of the trees in the forest ; the remaining trees belong to a variety of genera, such as *Olea*, *Warburgia*, *Rapanea*, *Celtis*, *Toddalia* and *Dombeya*.

(*f*) *Bamboo Forest* (*Arundinaria alpina*), is found between 7,500 and 10,000 feet ; then they are succeeded by open moorland, characterised by giant heaths (*Erica arborea*), *Hypericum lanceolatum* and *H. Schimperi*. The bamboo forest is almost pure, with a few *Podocarpus milanjianus* in it.

3. Area of the Forests.

The exact areas are not known and only rough estimates are given :—

Class of Land.		Square Miles.	Per cent. of Total Area.
Agricultural Land		47,170 ..	19·24
Forests, Merchantable	3,600		
Forests, Unprofitable	1,500	5,100 ..	2·08
Other Lands.		192,790 ..	78·68
Total		245,060 ..	100·00

Bamboo forests, estimated at 1,300 square miles, are included under Merchantable Forests.

4. Ownership of the Forests.

The State has retained the ownership of nearly all the forests. The classification is given as follows :—

	Square Miles.	Per cent. of Total Area.
State Forests for Timber production	2,200	43·14
Other State forests . . .	2,800	54·90
Total	5,000	98·04
Private forests	100	1·96
Grand total . . .	5,100	100·00

An area of 300 square miles is subject to a forest concession, which will expire in 1957. Much of the forest has been cleared for shifting cultivation, and in other parts all good timber has been cut out.

5. Forest Products.

Timber.—The more important timber trees have been given above. Of these Cedar and Podo are the most important, and next Muzaiti. Cedar has a wide distribution, reaches a height of 90 to 100 feet, a diameter of 36 to 48 inches, and the timber weighs 38 to 42 pounds per cubic foot, is durable and resists termites, but it is liable to attacks by *Fomes juniperinus*. Podo, a medium-sized tree, has a wide distribution ; it is said to be identical with the Yellow Wood of South Africa. Muzaiti reaches a height of 120 feet and a diameter of 6 to 8 feet ; its timber weighs 34 to 36 pounds, is durable and resists termites.

Other Produce.—(1) Fuel woods are important as there are, apparently, no coal or oil in the Colony ; the demand is large for power and domestic fires.

(2) Poles from mangrove forests, in large demand for export.

(3) Mangrove bark, but the supply is at present small.

(4) Bamboos and soft woods for paper pulp.

6. Relationship of the State to the Forests.

A Forest Ordinance was passed in 1911, which contains provisions for the better protection of the forests and gives powers, amongst others, for the following purposes :—

(*a*) To proclaim any area a "forest area" and to make rules for the protection of trees and other forest produce in such area.

(*b*) Provision for proclaiming "demarcated forests" and the constitution of a board of 5 Forest Commissioners; no land within such areas to be alienated or rights granted except with the approval of the Governor-in-Council and the approval of not less than 2 Forest Commissioners.

(*c*) Provision of penalties for the breach of any rules published under the Ordinance.

Amendments of the Ordinance were made in 1915—1916 for special matters. General "Rules made under the Ordinance" were published in 1912.

Administration.—The forests are under the control of a Conservator of Forests who is assisted by 9 Assistant Conservators, 1 Forest Surveyor, 16 Foresters, 7 Assistant Foresters and 130 Forest Guards. The superior staff is recruited through the Colonial Office, and the subordinate staff (Asiatics and Africans) is locally instructed in its duties.

The objects chiefly aimed at by the Department are :—

(*a*) The conservation of the natural forests.

(*b*) Their protection against fire and against man.

(*c*) The exploitation of timber, firewood and other produce.

(*d*) The regeneration of the forests and the introduction of valuable exotic species.

The Cedar forests are very liable to damage by fire and their protection is very difficult; fire traces are cleared and the areas are patrolled during seasons of drought, especially along railway lines.

Some plantations have been established along the railways for the supply of fuel. Planting has also been done in connection with shifting cultivation. In forests worked for timber under the selection system, the planting of groups has been introduced; efforts at natural regeneration have so far been very disappointing, though cedar is said to regenerate readily if the mineral soil is exposed.

Large nurseries of fast growing exotics have been established, and the plants are sold by Government at cost price to settlers and planters. Advice is also given by Government Officers.

7. Revenue and Expenditure.

The following table shows the average annual revenue and expenditure during the years 1914—1919 :—

Revenue :	£	*Expenditure :*	£
Timber . . .	7,240	Establishments .	6,560
Firewood. . .	1,982	Travelling . .	2,174
Nursery trees . .	721	Labour . . .	1,663
		Stores . . .	478
Total . .	9,943	Total . .	10,875

The figures show a small deficit of £932.

8. Increment, Utilization and Industries.

No data are available to gauge the increment, and the estimates which have been made are so vague that they had better not be put on record. The same holds good as regards loss by fire, waste and decay.

The output from the Government forests, 6 years' average, is given as 3,388,080 cubic feet of timber and firewood, valued at £10,000.

Industries are at present restricted to the exploitation of timber and firewood, but it is expected that the manufacture of paper pulp from bamboos will be undertaken in the near future.

9. Exports and Imports.

The following data represent the averages for the 6 years ending March 31st, 1919 :—

	Quantity, cubic feet.	Value, £.
Exports, Timber . . .	327,421	.. 11,873
Imports, Timber . . .	159,642	.. 16,725
Excess of Exports over Imports.	+ 167,779	.. — 4,852

The greater part of the exports consists of Mangrove poles for the Persian Gulf and South Arabian ports. The export of other timber, valued at £1240, is of little importance, the cost of putting it on the market being as yet very high.

The imports have steadily decreased since 1914, but the value per cubic foot has greatly increased. Prior to the war, the imports consisted chiefly of conifers from Scandinavia and teak from Burma.

10. Summary and Outlook.

The question of increased export depends on the quality of the indigenous timbers and the cost of getting them to the sea. On the first point much further enquiry is necessary, while, at present, a railway haulage of 400 miles is necessary to get the timber to a port. Rapid progress in communications is said to be taking place, so that all the forests will soon be accessible for exploitation.

The object of the management of the State forest is, according to the local forest authorities, to maintain and increase the yield of timber. At the same time it is stated that the present rate of cutting is in excess of the rate of growth, owing to the failure to obtain natural regeneration. As a result there will be a shortage of timber for a period in the districts near the line of the Uganda railway as these forests have been drawn upon for the supply of wood fuel for the railway.

It appears to the author that the first endeavour of the Forest Department should be to obtain a more accurate knowledge of the area, composition and yield capacity of the forests. Until this has been obtained it is impossible to formulate a definite forest policy for the future. Next, a rational estimate of the requirements of the country, allowing for an expected increase, should be made, and an area sufficient to yield that quantity permanently should be converted into reserved State forests and taken under efficient protection and management. More particularly, shifting cultivation should be so regulated that damage in the permanent State forests is avoided; the latter should also be efficiently protected against fire. The opening out of the country by the construction of appropriate means of transport should receive adequate attention.

Professor Troup, of Oxford, has just inspected these forests on behalf of the Secretary of State for the Colonies, and his report will, no doubt, supply full information on the subject, though not in time to be utilized on the present occasion.

M. UGANDA PROTECTORATE.

(See sketch map on page 203.)

1. General Notes.

The Uganda Protectorate is situated between the 1st degree south and the 5th degree north latitude, and the 30th and 36th degree eastern longitude. Its area is given as 109,119 square miles, of which 16,377 are water; its population as 3,361,117, giving an average of 31 people to the square mile.

Topography.—The dominant features of the country are the mountain ranges on the west, north and east. In the west the Rewenzori rises to a height of 16,794 feet. The range in the north reaches its greatest height in Mount Agora, with 9,400 feet. On the east, Mount Elgon rises to 14,110 feet. A series of ridges and foothills project for many miles into the lower levels, the country being generally undulating, broken up by hills, rivers and swamps. There are several large lakes in the country, most of which are navigable.

The soil of the country is generally fertile, much of it consisting of a deep ferruginous loam and black cotton soil.

Climate.—The climate is, on the whole, very pleasant, though not exactly a "white man's country." The Nile valley is hot, but the temperature on the mountain ranges is cool and even cold, and varies little throughout the year. For most districts the average temperature seems to move between 60 and 80 degrees. The average rainfall of 43 stations is 53 inches, but it varies generally between 25 and 70 inches. Entebbe has a fall of 57 inches with a mean temperature of 70 degrees.

2. Main Types of Forests.

The forests are said to be fairly well distributed over the country but the information regarding them is very meagre. No attempt has been made to arrange them into specific types. Certain forests and various species are mentioned, the more important of which seem to be: —

Minzero Forest, about 50 square miles, near Lake Victoria; species: *Podocarpus gracilior*, *Baikiæa eminii*, *Xylobia eminii*, *Mimusops cuneifolia*, *Mæsopsis berchemoides*, *Alstonia congensis* and *Parinarium excelsum*.

Mabira Forest, one of the best forests and very accessible, 140 square miles, close to Jinje Port on Lake Victoria, containing much valuable timber and *Funtumia elastica*. Chief timbers: *Khaya anthotheca*, *Entandrophragma sp.*, *Pygium africana*, *Chlorophora excelsa*, *Dolichendrone platycalix*, *Cynometra Alexandra* *Albizia coriaria*, *Maba sp.*

Budongo and Bugoma Forests, near Lake Albert, about 320 square miles. Many fine trees, bamboos and rattan canes. Species: *Cynometra Alexandra* (an iron wood, forms over 40 per cent. of the stocking), *Alstonia congensis*, *Khaya anthotheca*, *Erythrophlæum guineense*, *Chrysophyllum spp.*, *Warburgia ugandensis*, *Balanides Wilsonii*, *Cassia sieberiana* and others.

Kabali Forest, in the western province, 230 square miles, at present inaccessible. It contains many of the species already mentioned, and, in addition, *Dactylopetalum ugandensis*, *Mimusops toroensis*, *Carapa sp.*, &c.

Malibigambo Forest, in western Ankoli, and about 40 miles from Mbarara; it contains about the same species as Kabali forest.

There are large unexamined forests on the slopes of Rewenzori and Mount Elgon, which contain *Podocarpus spp.*, *Faurea saligna*, *Erica arborea*, *Juniperus procera* and bamboos.

In the Savannah forests occur the Shea Butter Tree (*Butryospermum Parkii*), which covers large areas in the northern province, and *Chlorophora excelsa* throughout the eastern province.

3. Area and Ownership of Forests.

The Area of existing forests is estimated at not less than 1,200 to 1,400 square miles.

The Ownership of the forests belongs to the State, with the exception of certain areas in the Budanda Kingdom.

4. Relationship of the State to the Forests.

Legislation.—The Forest Ordinances and Rules provide for the control of the State forests.

The forests being chiefly evergreen, special fire protection has not been considered necessary in the past, but it is now being

instituted in the eastern province, where *Chlorophora excelsa*, growing on open grass land, has suffered considerably from fires.

The natural regeneration of the more valuable species in the natural forests is not good. A considerable area of open land has lately been reserved for planting, and about 450 acres have been stocked, but no details as to species, &c., are available.

Comparatively little is done to assist private individuals, as such assistance is seldom asked for.

The Forest Authority.—The Chief Forest Officer has almost complete control over the Government forests. He is assisted by two Assistant Forest Officers, a Manager of the Government Timber Supply, and a Native staff of foresters, guards and clerks. The essential duties of the staff are the exploitation, survey and demarcation of forest areas, the conservation and development of their resources, the issue of permits, the collection of forest revenue, &c. The superior staff is recruited through the Colonial Office. The native staff is given some training at centres where work is proceeding.

Details of revenue and expenses are not available. There is nothing to record as regards forest activity of municipalities, or private persons, societies and research. No data are available from which the Increment, Utilization, Imports or Exports could be ascertained.

5. Summary and Outlook.

It is believed by the local authorities that the annual cut is much less than the increment of all the forests, but the increment of the species at present exploited may be less than their utilization, owing to their being mostly mature trees with little regeneration. The object of the Department is, therefore, to bring, by proper silvicultural methods, the forests into a more normal condition, so as to provide a sustained and increasing yield.

The most urgent measure is the systematic exploration of the forests, to locate them and to estimate their areas, map them, estimate their contents and yield capacity. The latter should then be compared with future requirements and a scheme of management determined accordingly.

Professor Troup's forthcoming report is likely to replace this meagre account.

N. NYASALAND.

(See sketch map on page 203.)

1. General Notes.

The Nyasaland Protectorate is a strip of country about 520 miles long and from 50 to 100 miles broad, lying approximately between the 10th and 17th degrees south latitude and 33rd and 36th degrees east longitude. It has an area of about 43,608 square miles and a population of 1,138,000 people, giving 26 to the square mile.

Topography.—A large proportion of the Protectorate is mountainous and hilly country, which rises rapidly from 160 feet at the southern end to a general altitude varying from 2,000 to 4,000 feet. There are several mountain ranges which reach a maximum height of 9,843 feet. Lake Nyasa runs along the eastern boundary of the Protectorate. From it issues the River Shire and runs in a southerly direction.

Nyasaland is composed chiefly of metamorphic gneisses and schists. Graphite is of fairly frequent occurrence. Iron ores also occur. Crystalline limestone is found in a few places. There are also mica and talc schists. Through the gneisses and schists igneous rocks have intruded. Small outcrops of coal have been found.

Climate.—Nyasaland has two well defined seasons, the rainy season from November to April, and the dry season from May to October. The mean annual rainfall differs from 30 to 107 inches. In the mountainous country bordering Lake Nyasa the rainfall varies from 65 to 95 inches, but throughout the greater part of the country, especially that which lies between 2,000 and 4,000 feet, the rainfall varies between 30 and 50 inches.

The temperature in the Shire valley and on the southern shore of Lake Nyasa frequently rises to between 100 and 115 degrees in the shade during October and the early part of November, though the mean maximum for these tracts is about 88 degrees and the mean minimum 62. Throughout the highlands and elevated plains generally, the temperature during the hottest part of the year rarely exceeds 95 degrees.

2. Main Types of Forest Growth.

The local authorities divide the forest vegetation according to elevation into three main groups :—

On the black cotton soil flats at elevations under 2,000 feet, Acacias are found in abundance, namely, *A. nigrescens*, *pennata*, *Kirkii*, *arabica*, *albida*, *lasiopetala* and *suma*. In the Shire valley fairly large stretches of almost pure *Copaifera mopana* forests are met with on sandy soils ; also Borassus palm and *Hyphæne crinata* on the sandy flats at the south end of Lake Nyasa. Other conspicuous trees of the hot dry country are *Adansonia digitata*, *Cordyla africana*, *Prosopis Kirkii*, *Dalbergia Melanoxylon*, *Odina Wodier*, *Kirkia acuminata*, *Tamarindus indica*, and several species of *Sterculia*.

At all elevations between 1,000 and 4,000 feet, chiefly in the vicinity of streams, the more important timber trees are *Khaya senegalensis*, *Adina microcephala*, *Piptadenia Buchanania* and *Erythrophlæum guineense*. In the woods away from the banks of streams, the trees are mostly small, the most abundant kinds being *Uapaca Kirkiana* and several species of *Brachystegia*. Other trees appearing in this section are *Pterocarpus angolensis*, *Albizia spp.*, *Terminalia sericia* and others. There are also thickets of useful bamboos.

Between 4,000 and 7,000 feet elevation on the Mlanje mountain, patches of cypress (*Widdringtonia Whytei*) are the only bits of really heavy timber forest, scattered through which *Podocarpus milanjiana*, a small tree, is found. The more open patches between those of cypress are usually covered with a thick growth of tall shrubs.

The most important timbers are the Cypress, African Mahogany (*Khaya senegalensis*), *Adina microcephala*, *Piptadenia Buchanania* and *Pterocarpus angolensis*. Rubber-yielding plants are represented by species of *Landolphia*.

3. The Area and Ownership of the Forests.

This is not known ; that of the cypress patches amounts to about 4 square miles.

Ownership of Forests. The area of the land privately owned by Europeans is roughly 5,900 square miles ; all the rest is Crown

land ; much of it is occupied by natives, inside and outside the forests.

4. Relationship of the State to the Forests.

Legislation.—A Forest Ordinance of 1911, a Crown Lands Ordinance of 1912, and subsequent further Regulations deal, apparently, chiefly with regulating and controlling the cutting of trees on leased lands, especially as regards the *Khaya senegalensis*, the payment of royalties, &c. It is also laid down that, in the cases of leases of land, during the first 4 years an area equal to 10 per cent. of the total cultivated area shall be planted with approved species of forest trees and cultivated to the satisfaction of the Chief Forest Officer, that area to be subsequently raised to 20 per cent. of the cultivated area.

Administrative Methods.—The cypress woods are the only areas of natural forests at present protected against fire. The natural regeneration of these woods is somewhat poor, owing to a dense undergrowth. During the last 15 years a beginning has been made with plantations, and the following areas have, up to date, been stocked : With Cypress, 440 acres ; Eucalypts, 380 acres ; other species, 25 acres ; total, 845 acres. The Cypress plantations are making satisfactory progress, and the Eucalypts are making remarkable growth on good deep soil. Nursery plants have been supplied to natives free of charge.

The Forest Authority is a division of the Department of Agriculture, its staff in October, 1918, consisting of 1 European Forest officer and a number of native overseers and guards. A second Officer has now been added.

For the 5 years, 1915—1919, the average annual receipts amounted to £1,127, and the expenses to £975. The expenditure does not include the cost of labour employed in cutting timber for the Public Works Department. On the other hand, timber and firewood are given free of royalties to all Government Departments.

Private Activity.—European tobacco growers have planted about 2,500 acres chiefly with Eucalypts for the production of poles and firewood, owing to the growing scarcity of such material in some of the more densely populated localities.

Experimental Work.—A forest arboretum, extending over

35 acres, has been established, in which a variety of trees have been planted. Of these, *Cedrela Toona* is making rapid and vigorous growth, and it should be extensively planted. Many Eucalypts have done well, especially *E. salygna*, *rostrata*, and others. In deep, alluvial soil, *Tectona grandis* has made quite good growth but not in the ordinary red, clayey soils. Other trees which have done well are species of *Callitris*, *Araucaria*, *Cupressus* and *Artocarpus fraxinifolius*.

5. Increment and Utilization.

No data are available. No timber is exported from Nyasaland, and the imports are very small.

6. Summary and Outlook.

The normal annual consumption of sawn cypress timber by Government Departments is given as about 13,000 cubic feet. There should be no difficulty in supplying that quantity from the 2,200 acres of natural forests, of which about 1,500 are at present accessible. It is stated that, apart from the cypress forests, there is a lack of big timber, and that there is a growing scarcity of pole and firewood throughout the inhabited portions of the country. Under these circumstances, it is urgently necessary to ascertain as rapidly as possible the actual supplies as yet available and the demands likely to arise in the future. On the basis of the data thus obtained, a scheme of future forest policy should be drawn up. Above all, an increased and competent staff should be secured to carry out that programme, and more particularly to select and organise the area of permanent State forests necessary to secure future requirements of forest produce. This, it appears, would involve the establishment of a considerable area of plantations.

O. SWAZILAND.

Swaziland is situated on the eastern boundary of the Transvaal between the 25½ and 27½ degrees of southern latitude. It has an area of 6,500 square miles and a population of about 100,00, or about 15 to the square mile.

For the purpose of Forestry the country may be divided into two parts, the higher and the lower veld. The higher veld

comprises all the hilly part of the country at an elevation of 2,400 feet and over, amounting to about two-thirds of the country. There is not much commercial timber in this part; it consists chiefly of grasslands, but the banks of streams are fringed with trees. These fringes have been deprived of any useful timber wherever they were accessible.

In the lower veld the country is generally of a park-like character. The timber is rarely of large size, and of doubtful commercial value. There is a variety of species but none of outstanding merit. They are approximately the same as those which are found in Natal and Zululand.

Experimental plantations extending over about 150 acres have been made with exotic trees, which show that the following species thrive well in the higher veld: All kinds of Eucalypts, many pines and cypresses, the Australian wattles, and oaks.

P. SOUTHERN RHODESIA.

(See sketch map on p. 203.)

1. General Notes.

Southern Rhodesia is situated between the 15½ and 22½ degrees south latitude and 25th and 33rd degrees east longitude. It has an area of about 152,500 square miles, and a population of 838,284, of which 38,284 are Europeans; density about 5 to the square mile.

Topography.—The territory is divided into 2 parts by a watershed which runs, approximately, from south-west to north-east from Tegwan to Bulawayo, Gwelo, Charter and Marandellas, where it joins the mountain range on the eastern frontier with heights between 7,000 and 8,000 feet. The Rhodesian watershed keeps within a height of 4,500 and 5,000 feet. The area to the north-west of the divide is greater than that to the south-east. The slopes on both sides of the divide are relatively gentle, and in consequence, there is not much difference between them from a forest point of view, except that the south-eastern slopes are slightly cooler and somewhat moister, than those on the north-west.

Geology.—There are two great geological divisions:—

(1) The ancient metamorphic rocks which have been invaded

by granite and other intrusive rocks and contain all the gold reefs of the territory. The rocks of this division are the foundations of the country. They form all the highlands and much of the lower lying districts.

(2) Later sediments and lavas, including the coal measures and the basalts of the Victoria Falls. The larger and better known portion belongs to the Karroo system, having at its base the coal beds.

The gneissic granite usually forms a rolling bush-covered country of low relief, while the massive granite builds "castle" and "ball" kopjes, which form such a characteristic feature of the scenery.

Soils.—Owing to the configuration of the surface and the nature of the rainfall, the extent of alluvial soil is very limited. The soils which cover the widest area are the following :—

(1) The Red Clay Soil, occurs from end to end of Southern Rhodesia and is derived from the greenstone schists of the metamorphic group of rocks. These red clay soils are poor in lime.

(2) The Granite Soil, including the Gneiss soils, are generally gritty clay of a mixed grain.

(3) The Sandstone Soils are found over wide areas in the northern part of the country. Wind and water have played their parts in the formation.

(4) The Black Soil is well known for its fertility. It is not confined to depressions (*vleis*), but is also found on the flat tops of tabular hills lying there upon the level basalt lavas.

Climate.—There are two seasons, the rainy season from October to March, and the dry season, comprising the other six months. The rains are evidently due to the moisture-laden winds from the Indian Ocean ; they diminish in intensity on going westward from the ridge of high altitude running parallel with the east coast, from about 40 to about 20 inches.

The dry season has very little rain, and an absolute absence of rain during 4 consecutive months has been fairly frequent. On the Rhodesian plateau between Bulawayo and Salisbury the temperature varies between 72 in January and 56 in July. On the low-lying lands towards the Limpopo or the Zambesi and in

the Sabi valley the heat is more intense and temperatures between 100 and 110 are not rare. Frosts at night occur every year. Droughts occur occasionally and are responsible for considerable mortality amongst indigenous and exotic trees.

2. Main Types of Forest Growth.

Southern Rhodesia is well wooded, being covered more or less with trees and shrubs over about 60 per cent. of the entire area. The forest growth can conveniently be divided into two main types :—

(1) High or Close-Type Forest.
   (*a*) Evergreen forest consisting of tall trees up to 200 feet in height with *Khaya nyasica* dominant.
   (*b*) Evergreen forest of the upper mountain slopes with trees up to 80 feet in height, with *Cussonia umbellifera* and *Eugenia spp.* dominant.

(2) Savannah Forest.
   (*a*) Deciduous forest confined to the Kalahari sand belts in the north-west portions of the territory, with *Baikiæa plurijuga* dominant.
   (*b*) Deciduous forest confined usually to lower slopes and valley bottoms in the hotter parts, irrespective of the geological formation, with *Copaifera mopani* dominant.
   (*c*) Deciduous forest spread over the greater part of the plateau and hills, irrespective of the geological formation, with *Brachystegia spp.* dominant.

The number of species in the several types is considerable, and certain species are found scattered in most of them, notably *Diospyrus mespiliformis*. There is also a stream-bank flora, which has characteristics of its own, and in different parts of the country has different constituent members.

With the exception of a small area on the mountain ranges, which has high or close-type forests in specially favoured spots, the forests are of savannah type with a park-like appearance. The trees, as a rule, are small with large spreading branches. The recurring veld fires do a considerable amount of damage, so that trees of large dimensions are mostly faulty and of little economic value, except for fuel.

3. Area and Ownership of the Forests.

		Square Miles.	Per cent. of Total Area.
Agricultural Land . .		2,209 ..	1·5
Forests, Merchantable .	18,300	..	12·0
Forests, Unmerchantable .	73,200	..	48·0
Total Forests .		91,500 ..	60·0
Other Land . . .		58,791 ..	38·5
Grand Total. .		152,500 ..	100·0

The different types of forest participate in the area as follows :—

	Square Miles.
Type 1a. Khaya forests . . .	2
Type 1b. Cussonia and Eugenia . .	20
Type 2a. Baikæa	9,141
Type 2b. Copaifera	18,285
Type 2c. Brachystegia. . . .	64,048
Forest of exotic Trees	4
Total	91,500

The division of the area according to proprietorship, is as follows :—

State Forests :	Square Miles.	Per cent. of Forest Area.
For Timber production .	—	—
Other Forests . . .	36,600 ..	40
Total State Forests .	36,600 ..	40
Corporation Forests . . .	18,300 ..	20
Forests of Private Individuals .	36,600 ..	40
Total	91,500 ..	100

4. Important Timbers and Other Produce.

The most important timbers are :—

Lovoa Swynnertonii, called "brown mahogany," a huge tree attaining up to 160 feet in height with a straight bole up to 90 feet long and a diameter up to 6 feet. Heartwood very durable.

Khaya nyasica, red mahogany, a huge tree of the same class timber with handsome grain and durable.

Trichelia chirindensis and *emetica*, the former a large, and the latter a smaller tree. The timber of both is valuable.

Schefflerodendron gazense, large tree, timber hard and heavy.

Pygeum africanum, large tree, one of the best South African timbers.

Callitris Whytes, a medium sized tree, the best local timber.

The above are all trees of the Close-type forests. The following trees belong to the Savannah forests :—

Baikiæa plurijuga, Rhodesian teak or Red wood, timber hard, heavy and durable. Boles short, up to 20 feet long.

Copaifera colesperma, a mahogany, fairly large tree, otherwise like the former tree.

Pterocarpus erinaceous, called " bloodwood," widely distributed, the heartwood excellent for cabinet work.

Afzelia cuanzensis, pod mahogany, a handsome tree with valuable timber, useful for furniture, waggons, &c.

Diospyrus mespiliformis, widely distributed over South Rhodesia, timber excellent for waggon building, mining work and carpentry.

There are many other kinds of useful timbers, but the kinds which could replace the softwoods are extremely limited. Hence, it would be desirable to plant suitable softwoods (conifers) with a view to replacing the imports later on.

5. Relationship of the State and the Forests.

Legislation.—The laws in force dealing with aspects of forestry are the " Forest and Herbage Act, 1859," of Cape Colony, Ordinances of the Rhodesian Legislative Council and Regulations framed thereunder. The right to cut wood for legitimate mining purposes was secured to the mining industry under the " Mines and Minerals Ordinance, 1903," and an Amendment Ordinance, 1908. Under these Regulations 60 per cent. of the mines obtain their wood supplies free of royalty, but, owing to scarcity in certain localities, 40 per cent. of the mines have to pay full market price for the necessary wood. Certain restrictions are imposed, such as the prohibition of cutting trees under 3 inches diameter, or of cutting within 50 feet on either side of the banks of all public streams. In 1913 an Ordinance was issued to prevent the

destruction of herbage, trees, and shrubs by fire. Certain species of trees are specially protected in various districts.

The recent appointment of a trained forest officer is likely to lead to further legislation, more particularly as regards fire protection, the planting of light woods and natural regeneration.

Assistance given to Forestry.—Nursery stock has been given at low rates ; the number of trees amounted in 1919 to 109,000.

The Forest Authority consists at present of 1 trained Forest Officer who is subordinate to the Director of Agriculture. He was appointed in January, 1920.

Education, Research and Experimental Work.—Certain data bearing on various aspects of forestry have in the past been published in the *Journal of Agriculture.* A limited amount of research work has been undertaken on the properties and uses of timbers and other forest produce. Experiments with indigenous and exotic species have been made in the Salisbury nursery. No other facilities for instruction in forestry exist as yet, but considerable interest in the growing of timber is now taken, and there is a reasonable prospect that in time the country's wants will be supplied from home-grown timber.

6. Increment and Utilization.

The data available at the present time are not sufficient for even an approximately correct account of either the increment or utilization ; only rough estimates can be given. The following information has been given by the local Forest Officer. The growing stock in the 91,500 square miles of indigenous forest is estimated at 11,771,187,200 cubic feet, which gives an average of 201 cubic feet per acre.

The increment on the 73,200 square miles of at present inaccessible forests is estimated as equal to the annual waste by fire and natural decay. The net increment on the 18,300 square miles of merchantable forest is estimated at 42,681,472 cubic feet, or about 4 cubic feet per acre and year.

The annual utilization has been estimated at :—

	Cubic feet.		Value, £.
Sawn timber, mine props, poles, &c. .	4,801,553	..	92,714
Fuel for Europeans, Natives and Mines	56,656,800	..	71,427
Total Timber and Fuel . .	61,458,353	..	164,141

7. Exports and Imports of Timber.

The data supplied by the local authorities are not quite clear; they are believed to be :—

	Cubic feet.	Value, £.
Exports	34,121 ..	10,490
Imports	258,122 ..	42,536
Excess of Imports .	224,001 ..	32,046

8. Summary and Outlook.

	Cubic feet.
Utilization	61,458,353
Less Exports	34,121
	61,424,232
Plus Imports	258,122
Total Home Consumption . . .	61,682,354
Annual Increment	42,681,472
Excess of Consumption over Increment	19,000,882

This deficiency is likely to increase considerably, as the population is sure to increase, causing not only a larger consumption but also deforestation of wooded areas. On the other hand, additional areas can be made accessible to traffic, and the forest authority should take immediate steps to reduce waste and to improve the annual increment by a more careful management of the forests. In addition to these measures, early steps should be taken to establish permanent State forests on unalienated land, sufficient to secure a permanent supply of timber and other forest produce; to take these areas under systematic management, and to induce private proprietors of forests, as far as possible, to husband the existing stocks. It is also desirable to establish a considerable area of soft woods by planting fast-growing species, especially conifers.

Q. NIGERIA.

(See sketch map on page 203.)

Nigeria is situated between 4th and 14th degrees north latitude and 3rd and 14th degrees east longitude. It has an area of

335,700 square miles, and a population of 17,250,000 people, or 51 to the square mile.

1. Short Description of the Topography and Climate.

The country may be divided into 4 main zones differing in their characteristics, namely :—

(*a*) A belt of swamp and mangrove forest which follows the coastline and varies from 10 to 60 miles in width, including the delta of the Niger, and intersected by numerous rivers and creeks.

(*b*) A belt of dense tropical forest from 50 to 100 miles broad, intersected by rivers and streams, and very rich in oil palm trees, which constitute at present the chief wealth of Nigeria. The ground is undulating with a few scattered hills, but there is no open ground except around villages and for farms. This belt changes gradually into (*c*).

(*c*) A belt of more open country which gradually becomes clearer and parklike, being followed by open expanses covered with high grass. This zone is hilly. It is followed to the north by (*d*).

(*d*) A vast undulating plateau at about 2,000 feet elevation with occasional hills of granite and sandstone rising to over 6,000 feet. The southern part of the plateau is covered with thin forest, but the country becomes more open towards the north, until at last the sandy tracts are reached which border on the Sahara.

The main river of the country is, of course, the Niger. It rises to the north-east of Sierra Leone, and after flowing for hundreds of miles through French territory, enters Nigeria from the west, runs in a south-easterly direction, takes in the Benue, its principal tributary, at Lokoja, about 250 miles from the sea ; it then flows to the south until it reaches about 5½ latitude, when it divides into numerous interlacing channels, which empty their waters into the Gulf of Guinea. Two other important tributaries, the Sokoto and Kaduna, join the Niger within Nigerian territory. The only other river of importance is the Cross, which enters the sea close to the eastern boundary.

The Climate of Nigeria is not good, except perhaps on the northern plateau ; hence, Europeans require a periodical return

to a more temperate climate. The seasons are well defined. The dry season lasts in the south from November to March, and the rainy season occupies the other 7 months ; in the north the latter is reduced to about 5 months. During the dry season the "Harmattan" blows, a north-easterly wind which brings with it from the Sahara a thick haze composed of minute particles of dust. During the harmattan the nights and early mornings are cold, but the days are very hot.

The Temperature varies, according to situation and elevation, as follows :—

Minimum from 45 to 70 degrees.
Maximum from 93 to 117 degrees.
Mean annual from 72 to 84 degrees.

Rainfall.—The approach of the monsoon or "rainy season" is inaugurated by numerous tornadoes. In the south the wind then blows from the south-west bringing a heavy rainfall to the country near the coast, which gradually decreases on proceeding inland. In the Niger delta the fall varies between 100 and 150 inches. Then comes a belt with a fall between 75 and 100 inches, which, near the northern edge of Lower Nigeria is reduced to below 75 inches. The rainfall of Northern Nigeria does not exceed about 56 inches, and on the northern edge as little as 16 inches have been recorded.

2. Main Types of Forest Growth.

The character of the different types of Nigerian forest is, apart from elevation, mainly determined by the amount of water at the disposal of the plants. They are :—

(*a*) *The Mangrove Swamp Forest* is confined to the tidal areas of the rivers and lagoons, between high and low water mark. The forest practically consists of *Rhizophora racemosa*, *Rh. mangle* and *Avicennia africana*.

(*b*) *The Freshwater Swamp Forests* occur chiefly in the vicinity of the larger rivers, and they are often due to their overflow ; they occur also in the deeper valleys of the hills. Important species are *Lophira procera* (the Red Iron Wood), *Mitragyne macrophylla*, also *Raphia vinifera* (the Bamboo Palm), and *Calamus Barteri*. The red iron wood is considered the most durable timber on the West

coast; the fruit of the tree is rich in oil. The valuable "piassava fibre" is prepared from the leaves of the bamboo palm.

(*c*) *The Moist Evergreen Forest* contains trees of very lofty growth scattered amongst those of more moderate height. Amongst the largest are: The *Khayas spp.* (Mahoganies), *Entandrophragmas* (Scented Mahoganies), *Chlorophora excelsa* (West African Teak), species of *Triplochiton, Terminalia, Eriodendron, Bombax, Mimusops* and others. Other components are species of *Gaurea, Lovoa, Parkia, Alstonia, Funtumia, Pterocarpus, Canarium, Elacis guineensis* (the Oil Palm), and many others. This type of forest is the most valuable in the country; it forms a belt lying 50 to 100 miles from the coast and is confined to the zone of heavy rainfall; much of it has been destroyed by the natives for agricultural purposes. Many of the trees are also found over extensive tracts which have a smaller rainfall. This type of forest is found in the vicinity of the larger rivers and other collections of water and is then called "Fringing Forest."

(*d*) *Mixed Deciduous Forest*, with a well-marked dry season, is rich in plants of economic value. It contains a number of evergreen species from the moist evergreen forest, which are generally found in the moist parts near streams or on northern aspects, while the deciduous species occur mainly on the drier soil and on southern and western aspects. The number of species is large, such as *Sterculia spp., Zanthoxylon senegalensis, Afzelia africana, Albizzia fastigata, Afrormosia laxiflora, Mimusops sp., Ficus, Diospyrus, Terminalia, Funtumia, &c.*

(*e*) *Savannah Forest* is a parklike formation, rich in herbs and grasses. The number of trees varies with the nature of the soil. On stiff laterite the trees are widely scattered and dwarfed, while alluvial hollows and narrow valleys are well stocked, though not to the same extent as the mixed deciduous forest. Fires occur early in the dry season and do great damage. The average height of the trees is less than in the moist evergreen and deciduous

forest, but occasionally gigantic specimens of *Chlorophora excelsa*, *Eriodendron anfractuosum* and *Adansonia digitata* (baobab) are met with. Other trees are: *Khaya senegalensis*, *Pseudicedrella Kotschyi*, *Tamarindus indica*, *Parkia*, *Afzelia*, *Acacia*, *Anogeissus*, *Terminalia*, *Vitex*, *Lophira alata*, *Borassus Æthiopica* (the Fan Palm), and *Phœnix reclinata* (the wild Date Palm).

(*f*) *Thorn Forest* exists in the dry northern part of the country, consisting largely of Acacias, of which the gum-yielding species are *A. verek*, *seyal*, *arabica* and *Sieberiana*. These gum forests gradually give way to low, open, thorny scrub in the vicinity of the desert.

3. Area and Ownership of the Forests.

The available information is as yet very deficient, and the following data are mere estimates in square miles:—

			Per cent. of Total Area.
Agricultural Land		100,800	30
Forest, Merchantable	50,400		15
Forest, Unprofitable	168,000		50
Total Forest		218,400	65
Other Land		16,500	5
Grand Total		335,700	100

The areas are continually undergoing reduction owing to the shifting cultivation practised by the natives. Roughly speaking, at the present time the forest area is divided as follows:—

	Per Cent.
Mangrove jungle	2
Tropical rain forest	10
Mixed deciduous forest	8
Savannah and Bush	45
Desert, scrub and water	5
Cultivated and fallow land	30
Total	100

The greater part of the forests has been entered as at present "unprofitable," and even of the merchantable forests only a small part has so far been exploited, owing to the primitive methods of extraction, the radius of exploitation being limited to 3 miles from the main waterways.

4. Ownership of the Forests.

Practically all the forests belong to the native tribes and communities of Nigeria; there is no individual ownership. Some forests have been given to Government, others have been constituted reserves by agreement with the Emirs or paramount chiefs. All forest reserves are under State control and management.

	Square Miles.	Per cent. of Total Area.
Areas belonging to the State . .	3,144 ..	1·43
Areas belonging to Corporate Bodies	215,256 ..	98·57
Total	218,400 ..	100·00

5. Important Produce.

Timbers.

The so-called "Protected Trees" are entered in a schedule issued under the Forestry Ordinance, arranged into a number of classes. Those of the first and second class are the following:—

Class I.—Khaya spp. (Mahoganies), found in the tropical evergreen and mixed deciduous forests. No tree under 11 feet girth is allowed to be cut.

Entandrophragma spp. (Scented Mahoganies) grow to a larger size than the *Khayas* found in the same localities. Minimum girth for cutting, 11 feet.

Chlorophora excelsa (known as Iroko or African Teak) is one of the best Nigerian timbers. Weight about 49 lbs. per cubic foot.

Gaurea Thompsonii and other species (Cedars) are found in the moist evergreen forest producing good timber, of which small quantities are exported.

Lovoa Klaineana (sold as Walnut), a tree of the moist evergreen forest, a good timber, obtainable in large sizes.

Sarcocephalus esculentus, a large tree, used for canoes; a valuable timber, durable.

Class II.—Mimusops d'jave, a gigantic tree, good timber, found in moist evergreen forest, not very plentiful.

Canarium Schweinfurthii, found in moist evergreen forest, good timber.

Detarium guineensis, in the mixed deciduous forest, great size, good timber; this and *D. senegalensis* are found in the Savannah forest.

Afzelia africana, a large tree of the mixed deciduous forest, a valuable timber.

Lophira procera, a large tree of the swamp and evergreen forest, a hard timber; the most durable timber known in Nigeria; weight 72 lbs. per cubic foot.

Other Forest Produce.

The most valuable forest produce is the palm oil, obtained from *Elœis guineensis*. The tree yields both the palm oil and palm kernels of commerce; it also provides the natives with palm wine.

Raphia vinifera produces "piassava" fibre and also a palm wine.

Borassus æthiopica stems, when split up, make very good rafters, much used for native houses.

Rubber from *Funtumia elastica*, *Landolphia sp.* and *Clitandra sp.* is a rapidly decreasing product.

The Public Works Department uses chiefly the following timbers: *Chlorophora excelsa*, *Sarcocephalus esculentus*, *Mitragyne macrophylla*, *Terminalia superba*, *Lophira procera*, *Erythrophlœum guineense* and *E. micranthum*. The most frequently exported timbers are: the Mahoganies (*Khaya spp.*), the so-called Cedars (*Entandrophragma spp.*) and the Walnuts (*Lovoa* and *Gaurea spp.*).

6. Relationship of the State to the Forests.

Legislation.—Under the Forestry Ordinance of 1916 the Governor may:—

(*a*) Appoint Forest Officers.

(*b*) Constitute certain lands as Forest Reserves.

(*c*) Acquire from any native or native community by agreement any lands producing or suitable for producing forest produce, or the right to take forest produce.

(*d*) Prohibit certain acts in a Forest Reserve.

(*e*) Make regulations to protect and regulate the taking of forest produce both in reserved and unreserved forests, and to provide for the collection, payment and the disposal of fees and royalties on forest produce.

The Regulations constitute certain timbers " protected timber," and this may not be taken for sale or export until the prescribed fees and royalties have been paid.

The protected trees are arranged into 8 classes according to value. The fees range from 92 shillings for mahogany to 3 pence per tree for mangrove poles, and the royalties from 20 shillings for mahogany trees to 6 pence. A minimum girth limit is also fixed for all trees, ranging from 11 feet for mahogany to 3 feet.

Certain articles of minor produce such as rubber, bamboos, fibres and grass are also protected, and fees and royalties fixed for them.

Timber licences are granted by owners of protected trees on native and communal lands, with the consent of the Governor, for areas not exceeding 100 square miles, for a period of 5 years, with the right of renewal with the approval of the Director of Forestry. Detailed conditions are appended to the licence, one of which provides for the planting of 24 seedlings for every big tree cut. Similar permits are given for the removal of minor produce.

It will be seen that the State has authority to protect and control the management of the forests, but the Forest Authority is not supreme, as forest reserves cannot be constituted without the consent of the native owners of the land. Such consent, though frequently obtained by the exercise of political and administrative influence, is not always given, in which case the State is powerless to act.

It is an offence under the Forestry Ordinance to set fire to any grass in a forest reserve without taking due precaution to prevent its spreading.

With a view to the regeneration of the natural forests, some planting has been done on cut-over and old farmed land, and such plantations are extended yearly.

Most of the forestry in Nigeria is carried on by the Government. Some Native Administrations have their own forest staff, but in

nearly all cases the work is carried out under the advice of a Government forest officer.

The Forest Authority.—The present staff is as follows : Director of Forests, 1 ; Conservators of Forests, 11 ; Assistant Conservators, 12 ; European Foresters, 13 ; Native Staff Rangers, Foresters and Forest Guards, 250.

Conservators hold charge of Circles, and Assistant Conservators of Divisions. European Foresters are in charge of plantations and departmental timber exploitations under a Conservator. Practically all charges correspond with the political divisions of the country.

The functions of the Department are at present confined to administering the provisions of the Forest Ordinance as regards protected trees and protected minor produce, the constitution of forest reserves and to experimental planting. When the staff has been increased it will be possible to undertake a more detailed inventory of the forests and the preparation of Working Plans.

The cost of the Department is as follows :—

	£
Cost of staff . . .	17,305
Other charges . . .	10,105
Total cost . .	27,410
Receipts	20,780
Deficit . . .	£6,630

The Forest Department exploits all the timber (about 500,000 cubic feet) required by the Public Works Department.

Several companies and private individuals exploit mahogany and also so-called African walnut and teak. They hold licences giving them the exclusive right to extract these timbers from definite areas. One company exploits mangroves only.

Education, Research and Experimental Work.—The recruitment of the European staff is generally done by the Secretary of State for the Colonies. A school for the training of the native staff was started, but it had to be closed down again owing to the shortness of the European staff.

No attempt at special research has as yet been made. Experimental planting with indigenous and exotic species has been done

with a view to investigating silvicultural questions. The total area of plantation is 950 acres.

7. Increment and Utilization.

There appear to be no data available by means of which the increment of the forests could be determined. As regards destructive influences, the most fatal is the shifting cultivation carried on by the natives. Next to that comes damage by fire, especially in the savannah forests.

Nor can a satisfactory estimate of the Utilization be made, as the home consumption of the natives is only partially known. All that can be given is the number of trees felled under State control in the southern forests ; they were as follows :—

Annual average during the years 1917—1919 :—

Type of Produce.	Number of Trees.		Value, £.
Trees for Export . .	3,372		
Trees for Government Use.	3,178	Fees. .	19,153
Trees for Local Use . .	15,502	Royalties .	3,387
Mangrove Trees . .	2,903		
Total . . .	24,955		22,540

The cubic contents of the trees is not known except of those used for Government purposes. The latter contained 301,798 cubic feet, which gives 95 cubic feet per tree on an average.

8. Exports and Imports.

According to the data given by the Customs Authorities, the average annual exports and imports during the years 1912—1913, the last two years before the war, were as follows :—

	Cubic feet.	Value, £.
Exports	1,388,700 ..	92,319
Imports	1,185,800 ..	64,231
Excess of Exports .	202,900 ..	28,088

9. Summary and Outlook.

As the total increment is unknown, no comparison between increment and utilization can be made. If the shifting cultivation could be stopped, or at any rate regulated, the local authorities

think that supplies would probably be sufficient at the past rate of cutting for an indefinite period, but the probability is that the demand will increase, resulting in a reduction of the supplies of the more valuable species.

The following steps should be taken :—

(*a*) The reservation of much larger areas for timber production.

(*b*) The prohibition of shifting cultivation in the reserved areas, or, if that is not practicable, an efficient regulation of it, so as to reduce the damage to a minimum.

(*c*) An efficient examination of the more important forests at any rate, so as to obtain a proper knowledge of their contents and yield capacity. On the basis of that knowledge the maximum yield which the forests can stand should be determined, until more accurate working plans can be drawn up.

(*d*) A gradual improvement and extension of the road system and other means of transport.

(*e*) The introduction to the market of a larger number of indigenous timbers.

(*f*) A staff sufficient to carry out such a programme.

When sufficient progress has been made in these directions, research and other matters can be taken up.

R. THE GOLD COAST COLONY.

(See sketch map on page 203.)

1. General Notes.

The general conditions are approximately the same as in Nigeria ; hence, the following short notes will suffice for the present purpose :—

The Colony is situated between the 5th and 11th degree north latitude and the 1st and 3rd degree west longitude. The area, including Ashanti and the Northern Territory, amounts to about 80,000 square miles, with a population of 1,400,000, averaging 17 per square mile.

Topography.—Along the sea shore the ground is undulating ; in the eastern half of it is an extensive plain with dry savannah forest ; in the western half low hills come down close to the sea The interior is very hilly up to the central plateau of Northern

Ashanti, which is well wooded and rich in perennial streams. Beyond that plateau the dense forest gives way to open savannah with a poor water supply during the dry season ; the country is comparatively flat with isolated hills. The geological formation is very diversified.

Climate.—The average rainfall is said to vary between 21 and 78 inches, and the average temperature between 91 and 58 degrees, the relative humidity between 70 and 86 per cent. There are two periods of rainfall, from mid-May to the end of July, and from the beginning of September to mid-October.

2. Main Types of Forest Growth.

These are practically the same as those of Nigeria.

3. Area and Ownership of Forests.

The area is estimated as follows :—

		Square Miles.	Per cent. of Total Area.
Agricultural Land . .		11,000	14
Forest, Merchantable .	14,000		17
Forest, Unmerchantable .	24,000		30
Total Forest .		38,000	47
Other Land . . .		31,000	39
Grand Total .		80,000	100

There are no State forests. All the land belongs to Communities, and individual ownership is also recognised. The native authorities have alienated some 25,000 square miles, chiefly for mining purposes, for periods extending to 99 years. Of that area only 1,084 square miles were actually validated by the Courts.

4. Relationship of the State to the Forests.

Ordinance No. 20 of 1907 deals with the Forests. Under it Rules were issued regulating the export of timber. It is hoped that the Chiefs will proclaim suitable areas as Reserves. The Government encourages the Native Authorities to co-operate with the work of the State Forest Department by passing bye-laws for the protection of the forests. Forest offences are dealt with by Native Tribunals.

The Forest Staff.—Until lately the staff consisted of a Conservator and 4 Assistants, but 1 Deputy and 7 Assistant Conservators have now been added.

Financial Position.—The expenditure of the Department in 1920 amounted to £8,394, and the income was *nil.* It is expected to realise in future a sum of £8,000 annually by the levy of an export duty.

The Recruitment of the superior staff is effected by the Secretary of State for the Colonies, and that of the subordinate by the Governor and the Conservator of Forests from Natives of the Colony.

5. Increment and Utilization.

The Increment is estimated at	448,000,000	cubic feet.
The annual loss by fire, waste, etc., at	22,400,000	,,
Leaving a net Increment of	425,600,000	,,

This estimate is based upon the assumption that over an area of 14,000 square miles an average annual increment of 50 cubic feet may be expected, provided that shifting cultivation is kept out of it. The estimate of waste seems very low, and it seems risky to place the net increment at the high figure given above.

For Utilization the following data are given :—

	Cubic feet.
Timber :	
Export, chiefly Mahogany	1,383,500
Mines	315,000
Public Works and Private Firms	200,000
Total Timber	1,898,500
Fuel :	
Mining operations	8,275,000
Railway fuel	725,000
Total Utilization	10,898,500

The consumption by the Native population is not known.

6. Exports and Imports.

Average for 10 years :—

	Cubic feet.	Value, £.
Exports	1,383,500 ..	159,701
Imports	346,194 ..	44,953
Excess of Exports .	1,037,306 ..	114,748

The average annual exports of other forest produce were Rubber, 1,000 tons ; palm kernels, 9,000 tons ; palm oil, 1,000,000 gallons ; kopra, 650 tons ; and kola, 35,000 tons.

7. Summary and Outlook.

	Cubic feet.
Timber :	
Utilization	1,898,500
Less Export	1,383,500
	515,000
Add Imports	346,194
Total Consumption . . .	861,194
Fuel : excluding Native Consumption .	9,000,000
Total Consumption . . .	9,861,194

A comparison with the net increment is not possible, as the Native consumption is not known.

The important steps to be taken in the immediate future are :—

(1) To establish a sufficient area of Reserves, to place them under efficient treatment and protection, especially against shifting cultivation and fire.

(2) To open a regular propaganda with the view of convincing the Native proprietors that the preservation of the forests is essential for their own benefit, and for the country as a whole.

No reports were received by the Imperial Forestry Conference on Forestry in the Gambia and Sierra Leone Colonies ; hence, only the following few notes, chiefly taken from Unwin's "West African Forests," can be recorded here.

Gambia has an area of 4,000 square miles and a population of

146,000 inhabitants, or 38 to the square mile. Forests in the ordinary sense do not seem to exist now, but a certain amount of timber is obtained from the drier part of the Colony. Early in the nineteenth century a considerable amount of mahogany was exported, but the quantity is now very small. The oil palm exists and the average annual exports of kernels during the years 1910 to 1914 amounted to 479 tons valued at £6,571. The average annual exports of ground nuts during the same period amounted to 61,000 tons, valued at £530,000. The export of natural rubber has practically died out.

Sierra Leone has an area of 34,000 square miles, and a population of 1,100,000, or 32 to the square mile. Formerly, the whole area was probably covered with forests, varying from open savannah and deciduous to dense evergreen rain forest, similar to those of the Gold Coast and Nigeria. Now, scarcely 1 per cent. of the area remains under forest. The most important tract is the "Sierra Leone or Peninsula Mountain Forest" situated east of Freetown. Its area is given as 48 square miles, which is eventually to be extended to 75 square miles; it has been declared a Reserved Forest. There are other forests in several parts of the Colony.

The Peninsula Mountain Forest extends gradually from the water's edge to an elevation of 2,000 feet, with a rainfall of 100 inches. The growth is very luxuriant and the giant trees stand close together, consisting of a large number of species, hard woods, as well as soft woods. The most prominent species are given as:—

Lophira procera, red ironwood, very common. A species of Mimusops known as pearwood. *Afzelia africana*, the Rhodesian mahogany. *Oldfieldia africana*, known as African oak. *Pseudocedrela*, or cedar mahogany, which reaches a very large size. *Copaifera Salikounda*, the true gum copal. *Chlorophora excelsa*, known as rock elm. *Lovoa Klaineana*, African walnut. *Alstonia congensis*, a soft whitewood. *Eriodendron anfractuosum*, the cotton tree. Several species of *Albizzia* and numerous others. *Elais guieensis*, the oil palm, is scattered over the forest, but is found in larger numbers in abandoned farms.

The average annual exports of timber during the period of 1910 to 1915 amounted to 173,000 cubic feet, valued at £19,129. Other exports are palm oil and kernels, coffee, gum copal and rubber.

A forest department was formed in 1911, and a Forestry Ordinance was passed in 1912. Since then several forests have been declared reserved forests and taken under systematic management. It is hoped to make up to some extent for the great destruction practised in the past.

S. TRINIDAD AND TOBAGO.

Of the two islands which constitute this Colony, Trinidad is situated between the 10th and 11th degree north latitude and the 60th and 62nd degree west longitude. Tobago lies about 30 miles north-east of Trinidad. The area of Trinidad is 1,861 square miles, that of Tobago 131, making a total of 1,992 square miles. The Colony had a population of 330,000 people in 1911, giving an average population of 161 to the square mile.

1. Topography, Geology and Climate.

Trinidad.—The island may be divided into three belts. The northern belt consists of a range of mountains rising in two places to 3,000 feet. The second belt consists of an alluvial plain from 10 to 20 miles broad, lying to the south of the mountain range; it is drained by two rivers, of which one runs westward into the Gulf of Paria and the other eastward to the Atlantic Ocean. The third belt lies to the south of the plain and consists of undulating ground rising to a maximum elevation of 1,100 feet.

The northern range consists of metamorphic schists, sandstones and limestones with a small area of intrusive igneous rock. The central plain is alluvial and contains sandy soils, loams and clays in the west and some gravelly soils in the east. The undulating ground on the southern half of the island consists of tertiary formations with a few outliers of older rock. In these tertiary rocks petroleum has been found in considerable quantities. The output of oil during 1919 was 1,500,000 barrels.

The climate is tropical with a fairly heavy rainfall. The temperature at sea level ranges from a mean minimum of 67 in December to March, to 71 in May to October; the mean maximum varies from 87 to 88 in November, December and January to 91 to 92 in April, May, August and September. The mean annual temperature is about 78 degrees. The dry season

lasts from February to May, and the wet season from June to September; showery weather is the rule during the remainder of the year.

Tobago.—The island may be divided into two parts. The south-western part is of low elevation, and the north-eastern part consists of a range of hills which attain 1,800 feet in elevation. Coral rocks overlay the igneous rocks of the south-western part of the island; the remaining mountainous part consists of igneous rock, often weathering to a considerable depth, and forming a rich soil. The climate is much the same as in Trinidad, but the maxima and minima are slightly lower.

2. Main Types of Forest Growth.

There are two types: (1) the tidal forests, and (2) the mixed evergreen forests. The tidal forests cover an area of about 40 square miles and consist chiefly of mangrove (*Rhizophora*). They are worked for fuel and to some extent for tan bark. The mixed evergreen forests contain a few deciduous species, without, however, interfering with their general evergreen character. Above 1,500 feet elevation their character changes somewhat, but not sufficiently to divide the type into two. They are, as a rule, "high forest" with trees over 100 feet high. The principal species in this class of forest are:—

(1) *Cedrela odorata*, the Indian Cedar, a tree up to 120 feet high, yielding a wood which is reddish brown, scented, soft and easily worked; used for building, cabinet work and extensively for cigar boxes.

(2) *Mimusops globosa*, the Balata, 90 to 120 feet high, giving a hard, heavy wood, durable; used for bridge work, sleepers; yields balata.

(3) *Tecoma serratifolia*, giving a greenish, hard and heavy wood.

(4) *Carapa guianensis*, a kind of mahogany.

(5) *Vitex capitata*, called Black Fiddlewood.

(6) *Dimorphandra mora*, Red Mora, about the only species which appears gregariously, wood very hard, heavy, strong and durable, excellent shipbuilding wood.

(7) *Hymenæa courbaril*, the Locust, 70 to 90 feet high.

A considerable number of other species; also 2 species of bamboos and palms.

3. Area and Ownership of the Forests.

	Square Miles.	Per cent. of Total Area.
Areas.		
Agricultural Land	760	38
Forest, Merchantable	800	41
Forest, Unmerchantable	372	18
Forest total	1,172	59
Other Land	60	3
Total Area	1,992	100
	Square Miles.	Per cent.
Ownership.		
State Forests, for Timber production.	331	28
State Forests, others	816	70
State Forests, total	1,147	98
Private Forests	25	2
Total Forests	1,172	100

The whole area of the private forests is likely to be cleared for cultivation.

4. Relationship of the State to the Forests.

Legislation.—Under the Land Regulations the Governor may set aside land for the establishment of Forest Reserves, and he may also release such land from reservation. The local Legislature may by law prescribe the penalties for certain acts committed on Crown lands without sufficient licence. The Forest Ordinance, No. 42 of 1915, prescribes these penalties. They are higher in the case of illegal acts committed in reserved forests than on other Government lands.

Administrative Methods.—On the advice of Mr. F. A. Lodge, of the Indian Forest Service, given in the year 1900, over 300 square miles were selected and demarcated as Reserves, principally designed for the conservation of the water supply, and for protection against wind for the benefit of agriculture. The greater part of these reserves is available for the production of timber, but some areas are inaccessible, while others have poor soil. The fire

question is said to be not serious because the climate is damp and the dry season short. The last occasion when fire burnt a considerable area of forest reserves was in 1911—1912, which was followed by an increase in the natural regeneration of cedar (*Cedrela odorata*), the most important timber tree of the Colony. Outside the reserves, the fire seems to have done a considerable amount of damage to the second growth in overworked forests.

Plantations were commenced in 1908, and by the end of 1919, about 825 acres had been stocked with important indigenous trees as well as sample plots of teak, camphor and mahogany. The growth of trees is very rapid.

Natural regeneration in the indigenous forests is assisted by improvement fellings, 3,700 acres having been so treated by 1919. It is proposed to treat 1,200 acres annually in this way. Owing to the inadequacy of trained staff, working plans have not yet been drawn up for the reserves.

The Forest Authority consists of a Conservator, a Deputy Conservator and 1 European temporary Assistant; there is also a subordinate staff of 17 non-European Rangers. The Conservator works under the direct control of the Governor. The Rangers are placed under the orders of the District Administrative Officers, through whom the Conservator issues his orders. The Conservator issues licences within the reserves and also special concessions outside the reserves with the previous approval of the Governor. Ordinary licences for produce outside reserves are issued by the District Administrative Officers.

Assistance given to Forestry consists of advice given when asked for, the sale at cost price of approved seeds, also the sale of plants at reasonable rates.

Income and Expenditure.—During the years 1911—1914, the average annual receipts amounted to £5,952, and the expenses to £3,166, leaving a surplus of £2,786.

Recruitment and Training.—The superior staff has been recruited from the Provincial Forest Service of India; the subordinate staff is locally instructed in the practical aspects of management by the superior staff. Research has, up to date, been restricted to observations regarding the life history of the indigenous trees.

5. Increment and Utilization.

No data are available to prepare anything like an accurate estimate of the annual increment. A rough estimate puts the average increment per acre at 30 cubic feet, leading to an increment of 20,000,000 cubic feet for the forests under State control. No information is available as regards other forests. The Utilization has been estimated for the forests under State control as :—

	Cubic feet.	Value, £.
Timber . .	540,000 ..	58,000
Firewood . .	1,900,000 ..	15,000
Total .	2,440,000 ..	73,000

Under "Forest Industries" are mentioned the preparation of railway sleepers, saw mills, match factories and petroleum mining, but the number of people employed is not given.

6. Imports and Exports.

	Cubic feet.	Value, £.
Imports, Conifers . .	882,734 ..	64,658
Imports, Hardwoods . .	6,800 ..	620
Total Imports . .	889,534 ..	65,278
Exports, Hardwoods . .	152,000 ..	17,840
Excess of Imports .	737,534 ..	47,438

These data represent the average of the last 11 years. About three-quarters of the imported conifers came from the United States and the rest from British North America. The hardwoods came chiefly from British Guiana. The exports consisted almost entirely of Cedar (*Cedrela odorata*). They went principally to Holland, Germany and Austria before the war; since then they have gone to Holland, the United States and the United Kingdom.

7. Summary and Outlook.

Utilization	2,440,000
Less Exports	152,000
	2,288,000
Plus Imports	889,534
Total Home Consumption .	3,177,534

It appears that the home consumption is considerably below the home production. The consumption per head of population is about 10 cubic feet annually.

The Colony can, under a systematic management of its forests, doubtlessly grow all the hardwood which is likely to be required, and there seems to be no reason why it should not produce, in course of time, the required coniferous woods. It might even be possible to increase the export of *Cedrela odorata*, unless the population should very rapidly increase.

The measures to be taken in the immediate future seem to be :-

(1) To give to the Reserves a more permanent character and to see that no fresh settlements are effected in them.
(2) To institute a regular system of fire protection.
(3) To develop the system of regeneration of the Reserves at any rate, by natural means assisted by planting and sowing.
(4) To plant suitable areas with conifers, so as to make the Colony by degrees independent of imports.
(5) To prepare at an early date working plans, to provide for the systematic execution of these, and to secure a sufficiently educated staff for the purpose.

T. THE BAHAMAS.

1. General Notes on the Colony.

The Colony of The Bahamas consists of 18 principal islands, or groups of islands ; the whole number, large and small, amounting to several thousands. They are situated between the 21st and 27th degree north latitude and the 72nd and 79th degree west longitude. The total area is estimated at 4,400 square miles, with a population of 55,944 in 1911, making about 12 to the square mile.

The islands are all of the same formation, namely coral rock. In most parts the land is flat and little elevated above the sea, the maximum being 100 feet. On some of the islands are extensive tracts of swamps and marl below the level of high tides.

The soil is scanty but of a productive nature, so that vegetables, pineapples, bananas, citrus fruits, coconuts and fibrous plants are cultivated. On four of the islands extensive pine forests grow on so-called " pine barrens."

The climate is pleasant and salubrious. The mean temperature

in 1918 varied from 61 to 85 degrees. The total rainfall for the same year was 49 inches, the greater part of which fell in the months of June to September. The winter months are usually dry.

2. Types of Forest Growth.

The most important tree is the Yellow Pine (*Pinus bahamensis*). It appears on 4 islands, Abaco, Andros, Grand Bahama and New Providence, over considerable areas of pine barrens. The tree does not reach very large dimensions, but the timber is fairly good, lasting when used for inside work, but not in exposed positions. The right to cut trees, manufacture lumber or obtain turpentine on the islands of Abaco, Andros and Grand Bahama has been granted by licence to a company. Other woods are found but not in abundance, such as Logwood (*Hæmatoxylon sp.*), Lignum vitæ (*Quaiacum sanctum*), Madeira (*Swietenia*), Cedar (*Juniperus bahamensis*), *Cascarilla bark* (*Croton eleuteria*), &c.

3. Area and Ownership of Forests.

Much of the virgin forest has been cleared for cultivation, and in many parts scrub or low coppice has come up again. In the case of the pine forests, little land has been cleared owing to the inferior quality of the soil for agricultural purposes. The following is a rough statement of the existing areas of the Yellow Pine forests :—

	Total Area of Island, Square Miles.	Area of Pine Woods, Square Miles.	Per cent. of Forests.
Island of Abaco . .	776	160	21
Island of Andros . .	1,600	156	8
Island of Grand Bahama	430	110	25
Island of New Providence	58	7	12
Total . . .	2,864	433	15

The other species appear in single trees and small groups, so that no areas can be given.

The pine barrens, on which the pine forests stand, belong to the State, but, as mentioned above, the right to cut pine trees on Abaco, Andros and Grand Bahama has been let by licence to a private company. The pine woods on New Providence belong to the State.

4. Relationship of the State to the Forests.

There is no special forest legislation, but by various Acts trespass on Crown lands is prohibited, whether for the purpose of cultivation or wood-cutting; also the wilful starting of forest fires. The latter do occur, but are regarded more from the point of view of danger to adjoining cultivation than damage done to the forests.

No assistance whatever is given to the regeneration of the forests, there being no forestry staff.

The Forest Authority is represented by the Surveyor-General under the orders of the Governor. There are no public or private bodies interested in forestry, and no educational or experimental work is carried out.

Forest Industries are said to occupy from 150 to 300 people.

5. Exports and Imports.

	Cubic feet.	Value, £.
Exports, Yellow Pine	293,789	11,248
Exports, Hardwoods	17,300	685
Total Exports	311,089	11,933
Imports, Conifers	71,365	5,186
Excess of Exports	239,724	6,747

The above data represent the average of the years 1907 to 1913. The greater part of the hardwoods consists of Lignum-vitæ.

6. Summary and Outlook.

The local authorities consider that there is no indication of the forests becoming exhausted for many years to come at the present rate of cutting. The information is too incomplete to suggest any line of action in the immediate future.

U. BRITISH HONDURAS.

1. General Notes.

The colony of British Honduras is situated on the mainland of Central America between the 15th and 19th degree north latitude and the 87th and 89th west longitude. Its area is given as 8,598 square miles with a population in 1911, of 40,458, or about 5 to the square mile.

The front lands, along the so-called "Mosquito Coast," are low and swampy, and the country rises gradually until the high land at the back of the colony is reached. The northern part of the colony forms a plain of about 1,000 square miles. In the south are several ranges of hills rising up to 3,700 feet.

The prevailing type of formation is tertiary with underlying strata of granite, quartzite and carbonaceous shales, sandstones and limestones cropping up in detached ranges. The river valleys contain rich alluvial soil known as the Cohune ridges. They are the home of mahogany, cedar and logwood, and they also contain the chief agricultural areas. Between these valleys are large stretches of country covered with dry gravelly or sandy soil supporting scattered patches of pine trees and low palms. Further inland are elevated savannahs and open grassy country.

Numerous rivers descend from the interior mountains to the sea, and the bulk of the transport is done by water; the rivers are, however, navigable only for some distance. There are said to be no roads, and some 60 per cent. of the country is pronounced inaccessible, so that the timber supplies must remain so until the colony has been opened out by adequate means of transport.

Considering its position the colony has a moderate climate. The temperature at Belize ranges between 62 and 90 degrees. Sea breezes prevail during the greater part of the year. The average rainfall at Belize is about 81 inches. The dry season runs from the middle of February to the middle of May. There is rain during every month of the rest of the year. The heaviest falls occur during September, October and November.

2. Types of Forest Growth.

Unfortunately not much accurate information is available as regards the forests of British Honduras. This is all the more to be regretted as the colony is the chief source within the Empire of the true mahogany, and also because Honduras, with British Guiana, may one day become an important factor in the supply of hardwoods generally in the Empire. Many of the trees in the colony are as yet known only by their local names. The following notes on the forest vegetation are, therefore, very restricted.

Mahogany (*Swietenia Mahogani*) is said to produce the best

quality in the low lands not far from the sea, where it takes a dark colour. A somewhat similar colouring is produced in the lower parts of the valleys. A lighter coloured variety is produced on the slopes of the valleys. The next important species is Cedar (*Cedrela odorata*) which grows to a large size and yields a valuable timber, especially for cigar boxes and construction. Logwood (*Hæmatoxylon Campeachianum*), a valuable dye wood, grows in swampy parts along the sea and near rivers. A prominent feature is the presence of a Pine (*Pinus cubensis ?*) on the pine ridge, where it and the Pimento Palm are the dominating trees, though the former is said to give way in some parts to an oak (*Quercus virens ?*). There is a variety of other hardwoods, but the information regarding them is so uncertain that it is not worth recording it here.

3. Relationship of the State to the Forests.

There is no Forest Department in the colony, and the Governor has supplied the following information :—

Somewhat more than one-half of the area of the colony belongs to the State, so that nearly one-half seems to have been alienated, but it is not stated who the private proprietors are. The pine ridge area is given as 2,660 square miles, the cohune ridge, or the mahogany, cedar and forest area generally, is stated to comprise 3,300 square miles, the land under agriculture and pasturage as 40 square miles, and the rest as swamp, lagoons and waste land. It is not stated what proportion of the forest land is State property. It is, however, understood that large areas of forest have passed into the hands of companies ; one of these has quite lately engaged a scientifically trained and experienced Forest Officer.

4. Exports and Imports.

	Cubic feet.
Exports, Mahogany . .	735,333
Exports, Cedar . . .	51,372
Total Exports . . .	786,705
Imports, Lumber . . .	120,584
Excess of Exports . .	666,121

Of the mahogany, 213,285 cubic feet went to the United Kingdom, 517,406 to the United States, and 4,642 cubic feet to Spain. Of the cedar 14,926 went to the United Kingdom and 36,446 cubic feet to the United States. Of both mahogany and cedar considerable quantities were imported and forwarded to the United States. The imported lumber came from the United States. No information has been supplied as regards Increment or Home Consumption.

5. Summary and Outlook.

The most urgent requirement is the establishment of a Forest Department, placed under an efficient Forest Officer. Mahogany has been exported for something like 200 years, and if the supply is to be continued, the following measures seem to be urgently required :—

(1) A botanical and forestal examination of the forests, so as to ascertain the character and distribution of the important species of timber trees.

(2) To save as much as possible of the unalienated forests, especially those containing mahogany and cedar.

(3) To pass a Forest Ordinance providing for the proper protection and management of the forests still belonging to the State, and the reservation of the important mahogany and cedar forests.

V. BRITISH GUIANA.

1. General Notes.

British Guiana is situated between the 1st and 8th degree north latitude and the 56th and 62nd degree west longitude. It has an area of 89,480 square miles and a population of about 311,000 people, making between 3 and 4 to the square mile.

Topography.—The colony may be divided into three belts: (1) The alluvium belt, 5 to 35 miles broad. In the north it is a low-lying, flat and swampy strip of marine alluvium. It rises gradually from below the level of high tide to 12 feet above high-water level, and is interrupted in a few places by low hills of decomposed rock or by sand dunes rising to 30 or 40 feet in height.

(2) Sand and clay belts succeed the coastal region, forming a

broader and slightly elevated tract composed of sand and clayey soils. This belt is undulating and rising from 50 to 80 feet above sea level.

(3) The mountainous region follows the former on going west and south. It contains four principal mountain ranges, of various elevations, generally between 600 and 4,000 feet. The culminating point is reached in the flat-topped mountains Roraima and Kukenaam, which rises 5,000 feet above the surrounding country and 8,600 feet above sea level. The country is traversed by several large rivers which, with their feeders, form a vast network of waterways. All the large rivers are impeded above the tideway by rapids, cataracts and falls. The easily accessible portions of the Colony extend from the sea coast to these rapids, varying in breadth from 35 to 110 miles, and embracing about 18,500 square miles.

Geology.—The alluvial deposits are of considerable depth, ranging from 330 to 1,500 feet. They consist of marine muds and sands. Residuary deposits may be seen along the courses of the larger rivers, consisting mainly of arenaceous, argillaceous and laterite earths arising mostly from the decomposition of granite and gneiss. The residuary deposits are not infrequently traversed by long ranges of sand dunes rising to 100 and even 200 feet in height. The rock in the rapids is gneiss, in places intersected by granite.

In the mountain region very large areas are occupied by a thick formation of sandstones and conglomerates. Considerable areas are occupied by schists, while gneissose rocks are found over a large proportion of the country.

Climate.—The temperature in the coastal region ranges between 70 and 90 degrees, the mean minimum being 74 and the mean maximum 87 degrees. The temperatures in the forest regions are only slightly different from those in the coastal region. In the savannah tracts the range of temperature is greater than in either the coast or forest region, the mean maximum being 92 and the mean minimum 72 degrees.

In the coastal region there are two wet and two dry seasons: the long wet season extends from the middle of April to August, followed by a dry season which lasts to the middle of November; then comes the short wet season lasting to the end of January,

followed by a second dry season to the middle of April. The rainfall in the coastal region ranges between 91 and 101 inches, the lowest being experienced on the coast itself. In the forest regions the contrast between the wet and dry seasons is less marked, but the rainfall varies between 84 and 159 inches, according to locality. In the savannah region the rainfall is smaller than in the other regions, being on an average about 50 inches.

2. Types of Forest.

A considerable amount of information has been supplied by the local authorities, but it is not easy to give a clear account of the several types, as a large number of species are given by their local names only, and a very detailed classification of the types has been attempted.

On the whole, the forests are "mixed forests," in which, however, one or a few species are in the majority; many forests are known by the name of such prevailing trees. The height-growth of the different types of forest varies very much. On the low coast lands and along the lower tidal reaches of rivers, the height would be from 60 to 70 feet; further inland they reach 100 feet: on the higher lands the height rises up to 200 feet. Balata (*Mimusops globosa*) producing commercial balata, and black balata (*M. Elata*) reach a height of over 150 feet and a girth of 12 to 18 feet.

The forests of the easily accessible areas may be divided into two great divisions:—

(1) Forests covering the wide alluvium, mostly of a swampy nature.

(2) Forests of the slightly elevated country, plains, ridges, or higher hills.

Division (1) comprises the littoral woodlands, almost entirely composed of *Avicennia nitida*, *Rhizophora Mangle* and other species; in the river estuaries mangrove belts are found. Where the water ceases to be salt *Carapa guianensis*, Crabwood or British Guiana Mahogany, Wallaba (*Eperua sp.*), *Hieronyma laxiflora*, and several species of *Nectandra* appear. On flat lands slightly raised above tidal level appear forests, the chief constituent of which is Mora (*Dimorphandra Mora*), accompanied by *Carapa*

guianensis, Wallaba varieties, Corkwood (*Pterocarpus draco*), and others.

Division (2) comprises the most extensive forests of the easily accessible area; it is the most important commercially, as it contains most of the timbers of value which have been exported for nearly a century. Various kinds of Kakeralli (*Lecythis sp.*) are generally the dominant trees. In the forests bordering on Division (1), *Œnocarpus baccata*, *Mauritia flexuosa* and *Maximiliana regia* are plentiful. Greenheart (*Nectandra Rodiei*), which is of slow growth, is partly gregarious and also scattered in mixed forest; it is found in the lower parts of this division up to about 300 feet elevation. This timber has been exported for over 100 years and the most accessible areas have been denuded of it to a considerable extent. Wallaba (*Eperua falcata* and *Jenmani*) grow more or less abundantly throughout the greater part of the forests.

Balata (*Mimusops globosa* or *elata*) grows in most parts of the Colony, in the forests on the swamp lands and on elevated and hilly country. It has been estimated that in swampy lands the number of balata trees is less than 1 per acre, and on elevated and hilly ground 2 to 3 per acre.

3. Important Forest Produce.

The forests of Guiana contain a very large number of species of trees; some 300 have been enumerated, but there are probably a great many more. Only a few of these have, up to date, been marketed. Of many species the local names only are as yet available. Mechanical tests have been made on 15 kinds. The majority of the woods are hard and very hard. Of other forest produce, Balata is the chief item; it has formed an important article of export since the year 1863. Locust gum, the produce of *Hymenæa Courbaril*, is exported in comparatively small quantities. Other gums are obtained from *Protium heptaphyllum* and a species of the *Sapotaceæ* order. Rubber is obtained from *Sapium Jenmani* and some forest vines and lianes, but the industry is not of much importance. Tanning bark can be obtained from many trees. Crab oil obtained from *Carapa guianensis*, is used medicinally. Edible oils are obtained from *Maximiliana regia* and also from other palms.

4. Area and Ownership of Forests.

		Square Miles.	Per cent. of Total Area.
Agricultural Land . .		900	1
Forest, Merchantable .	13,000		15
Forest, Unmerchantable .	64,780		72
Forest, Total . .		77,780	87
Other Lands . . .		10,800	12
Grand Total . .		89,480	100

The area under temporary cultivation is given at about 150 square miles; it is not included under forest. On the other hand, Indian reservations, amounting to 1,360 square miles, form part of the forest area, while scrub and inferior savannah are shown as other land.

Of the total forest area, 900 square miles have been alienated to private persons; the remaining 76,880 square miles belong to the State. Licences, renewable annually and a few issued for 2 or 5 years, are granted by the Crown for wood cutting: 402 of these, aggregating 575 square miles, are in existence.

5. Relationship of the State to the Forests.

Legislation.—The Crown Lands Ordinance, No. 32 of 1903, provides that the Local Government, on behalf of His Majesty, may give absolute or provisional grants, leases, licences to occupy, or take specified substances including timber. Power is given to the Governor to revoke grants, licences, &c., for non-compliance with the terms or of the Regulations made under the Ordinance. The latter provides penalties for trespassers on Crown lands, appropriation of produce, wilful obstruction of navigable streams, &c.

The Commissioner of Lands and Mines, with the approval of the Governor, grants leases, licences, &c. Leases for tracts exceeding 5,000 acres require the special approval of the Governor. It is laid down that no tree shall be cut that will square less than 10 inches, except Wallaba or other hardwood trees of the like nature. Trees producing rubber or balata may be cut only on a written permission. Royalties have to be paid on the produce.

The Governor has power to resume any land included in a lease or licence, which may be required for a public purpose.

Licences to collect balata, gums, &c., are subject to special regulations. No balata tree may be tapped which is under 36 inches girth at $4\frac{1}{4}$ feet from the ground.

Administrative Methods.—No legislation exists in regard to fire protection or the regulation of shifting cultivation, and no attempts have been made to control or check the forest fires which occur during long periods of drought; nor has any planting been attempted. Natural regeneration is said to re-afforest, in the course of time, areas which have been cut.

Assistance given to Forestry.—A few experiments have been made in growing forest trees from seed. Expert advice has been obtained in botanical identifications from the Government Herbarium and from Kew Gardens. The Imperial Institute has published reports on timbers, palm oil and mangrove bark for tanning.

The Forest Authority.—A branch of the Department of Lands and Mines has been placed under a Forest Officer since 1910. His powers are limited; his reports are sent to the Commissioner of Lands and Mines, who would take any necessary action. Up to date a superficial preliminary examination has been made extending over about one-fourth of the existing forest area, consisting chiefly of the easily accessible parts. There are some 7 Forest Rangers, all being Natives, with assistants who patrol the principal rivers and the adjoining lands.

Receipts and Expenses.—The averages of the last 4 years were: Income = £14,062; Expenditure = £2,083, giving a surplus of £11,979. The expenditure does not, however, cover a certain amount of office work done in the office of the Commissioner of Lands and Mines.

6. Increment and Utilization.

No data are as yet available by means of which even a rough estimate of the increment could be made, or of the annual losses through fire, waste or decay.

As regards utilization the sub-joined data indicate only the quantities removed from the forests under State control:—

	Cubic feet.		Value, £.
Timber, under State control .	726,219	..	65,222
Other produce, including poles, &c.	?	..	180,482
Total	726,219	..	245,704

The number of persons employed in *forest industries* is given as follows, average of 5 years :—

On timber works, fuel cutting and charcoal burning	2,977 men.
On the collection of Balata . . .	3,594 „
Total	6,571 „

These numbers evidently do not include men employed in a variety of minor industries.

7. Exports and Imports, Annual Average of the Years 1909—1914.

	Cubic feet.		Value, £.
Exports, Logs and Scantlings .	310,451	..	24,544
Imports, Coniferous Lumber .	308,766	..	24,959
Excess of Exports . .	+1,685	..	−415

By far the greater part of the exports consists of Greenheart. The imports are called "pine lumber." Exports and Imports practically balance each other. Since 1914 the exports have considerably fallen off, while the imports have somewhat increased. The greater part of the exports has gone to the United Kingdom, and the rest to the United States, Canada, the West Indies, and Holland. The imports have practically all come from the United States and Canada.

The above data refer to timber only. Other forest products exported are, in value, largely in excess of timber. The following data have been supplied :—

	£ Period: 1909-14.		£ 1915-19.
Average annual Exports . .	137,278	..	199,906
Average annual Imports . .	18,137	..	41,172
Excess of Exports over Imports	119,141	..	158,734

This is a valuable and, apparently, increasing asset of much

greater financial value than that derived from the export of timber. By far the most important item of export is balata, while the imports consist of shooks and staves.

8. Summary and Outlook.

	Cubic feet.
Utilization	726,219
Less Exports	310,451
	415,768
Plus Imports	308,766
Total Home Consumption .	724,534

The home consumption is probably much higher than the official data indicate.

The local authorities state that the duration of supplies is "unknown." It seems, however, that an early effort should be made to acquire some knowledge on that subject, especially as the Guiana forests are evidently of greater value than the local authorities appear to realize. Although there are as yet great stores of hardwoods in the British Empire, destruction, waste and injudicious management are still rampant in many parts, and the forest wealth of Guiana may be called upon at an earlier date than may appear. Under these circumstances prompt steps should be taken in the following direction :—

(1) An efficient protection of existing stocks and especially against fire and other waste.

(2) The prohibition of settlement in selected areas situated within the accessible part of the country, with the view of converting them into permanent State forests for future supplies of forest produce.

(3) An adequate exploration of the at present inaccessible forests, the identification of the several species, and the quality of their timber, the opening out by means of transport to render the several parts of the forests accessible.

(4) The establishment of coniferous plantations on suitable areas in the accessible parts of the country, so as to avoid, or at any rate reduce, the import of such timber.

(5) The organisation of an efficient staff to do justice to these and other tasks.

W. OTHER BRITISH POSSESSIONS.

The information received from several other British Colonies and Protectorates is so meagre that no general description of the state of their forestry can be prepared ; hence, only the following short notes are given.

Jamaica has no Department of Forestry, and particulars regarding the growing timber are said not to be available. The Island was, at the time of its discovery, a well-wooded country with an abundance of fine timber, but it has not escaped the consequences of "the mark of civilization" (as the local authorities are pleased to call it) ; what now remains of forest is mostly inaccessible. All building materials are imported from the United States of America, at the cost of about £260,000 a year. Since the war, some attention has begun to be given to the native lumber supply question. Here the information given by the local authorities ends.

The Island of Jamaica lies between the 17th and 19th degrees of northern latitude, and it has an area of 4,207 square miles. Of that area, some 30 per cent. is still forest, or rather jungle. For a long time past shifting cultivation has been carried on over some 30,000 acres annually for the production of yams, ginger, and other vegetables ; the land is cleared, cultivated for a year or two, and abandoned. The result is almost complete denudation of the slopes of the Blue Mountains between 2,000 and 4,000 feet elevation. In the forests which now remain the most important trees are (or were) Cedar (*Cedrela odorata*), Mahogany (*Swietenia Mahogany*), Logwood (*Hæmatoxylon Campeachianum*) and Fustic (*Maclura tinctoria*). Of these a considerable export trade existed formerly, but it has now shrunk to very small dimensions, except in the shape of transhipments.

Although the authorities of Jamaica may be of opinion that forest conservancy is not necessary, as timber can be imported at cheap rates, the facts remain that deforestation is interfering with the water supply of several districts, and that forests also prevent, or at any rate reduce, a torrential flow of water in the rivers, thus protecting the low lands. Under these circumstances Jamaica will be wise in protecting, at any rate, the upper parts and slopes of the Blue Mountains and elsewhere.

The Bermuda Islands are well covered with woodlands. The dominant tree is the Bermuda Cedar (*Juniperus bermudiana*), which yields a durable timber, easily worked, and used for house and boat building, furniture and various other purposes.

No forest laws are now in force, but owners of property do not permit tenants to cut cedar without previous sanction. Measures of re-afforestation are not considered necessary. The average annual imports are given as 36,000 cubic feet of lumber valued at £5,500, and other timber valued at £19,000.

The Windward Islands, St. Lucia, have a fair amount of valuable woods, containing *Cedrela odorata, Ormosia dasycarpa, Hymenæa Courbaril, Calophyllum Calaba, Mimusops globosa, Chlorophora tinetoria, Phoebe elongata, Vitex dinaricata, Balata* and others. The average annual exports during the last 5 years were valued at £3,700, consisting of logwood, railway sleepers and other kinds of timber. The forests are included in the Crown lands and controlled by the Colonial Engineer, who employs a small native staff.

The Leeward Islands.—Only Dominica contains any forests, the utilization of which would, in the opinion of the local authorities, be hindered by the natural difficulties of the country. It is considered that the denudation of the forests would react prejudicially on the agricultural interests.

The Seychelles, in the Indian Ocean, have no forests, properly speaking, in the Colony, beyond a few clumps of primary jungle on inaccessible summits. Low secondary growth contains *Calophyllum inophyllum, Terminalia catappa, Abzelia bijuga, Heritiera littoralis*, &c. There is no forest service in the Colony.

Hong Kong has a scanty supply of the native pine (*Pinus Massoniana*), and a large quantity of China fir (*Cunninghamia sinensis*) is brought into the Colony, of which no account is kept. The following quantities of other timber were imported in 1919 :—

	Cubic feet.	Value, £.
Teak . . .	400,130 ..	109,485
Other Hardwoods .	1,148,385 ..	202,252
Pine, &c. . . .	746,996 ..	88,323
Total Imports .	2,295,511 ..	400,060

A forest service is maintained in the Botanical and Forestry

Department, consisting of two European Officers and a staff of Chinese foresters. There is also a temporary staff engaged during the planting season.

Pine plantations are being established for :—

(1) The conservation of the water supply.
(2) For the sake of revenue.
(3) For beautifying the country and preventing erosion of the hills.

A limited amount of Research is carried on by the European Officers in connection with plant diseases and local economic products.

Weihaiwei has not a separate forest service, but it is proposed to appoint an expert with the view of establishing a scheme of afforestation, as at present all timber has to be imported.

No statements have been received from North Borneo, Sarawak, Tasmania, the Sudan and Mauritius.

The Sudan.—The author regrets that he cannot give a complete account of the progress of forest conservancy in the Sudan. In the third edition of this volume it was stated that Mr. C. E. Muriel examined the country and reported on its forest resources in 1901. It appears from his report that the Sudan has a greater variety of trees than might be expected. Of these, the Acacias are the most important, some of which give a strong and durable but hard timber. *Cordia abyssinica* gives a durable timber which will float when dry. It also appears that in Bahr-el-Ghazal and in Kagalu forests exist, which contain fine mahogany trees; some timber of these has lately been brought to Khartoum. The obstacle to extensive exploitation seems to be the difficulty of transport. It is understood that the Government has now taken steps with a view to improving communications.

The difficulty of securing an adequate supply of firewood seems to be great, as the available wood fuel areas have been severely drained. Further cuttings had to be restricted and coal and oil used in spite of high costs. It is stated in the annual report for 1920 that steps are being taken to ensure natural regeneration in the overcut areas on the Blue Nile, as well as direct afforestation. On the White Nile the fuel supply areas in the vicinity of Khartoum have been severely cut. A scheme for the afforestation of

selected areas on the mud flats of that river is being studied, and is possibly now under execution. The Sudan authorities had good advice given to them in the past, and it is much to be regretted that they have lost so much time by indecision. It is stated that, to provide the necessary fuel in the future, an area of 100 square miles of fuel reserves is wanted.

Of other forest produce, Gum is the most important. It is obtained from Acacias, of which "hashab" (*A. verek*) is the most important; next to that comes "talha" (*A. seyal*). Small quantities are also obtained from "sant" (*A. arabica*). The gum comes chiefly from Kordofan, but also from Kassala. It is estimated that the Acacias are spread over an area of some 5,000 square miles, giving a handsome return.

The Sudan is rich in good fibres, of which that of "marak" (*Leptadenia spartium*) is the best. Tans are derived from the fruit pods of *Acacia arabica* and from the bark of *A. seyal*. Resin is obtained from *Balsamodendron pedunculatum*.

To sum up, there is no doubt that the Sudan is quite a promising field for real forest conservancy, and it is to be hoped that the question will soon be seriously taken up.

END OF VOLUME I.

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